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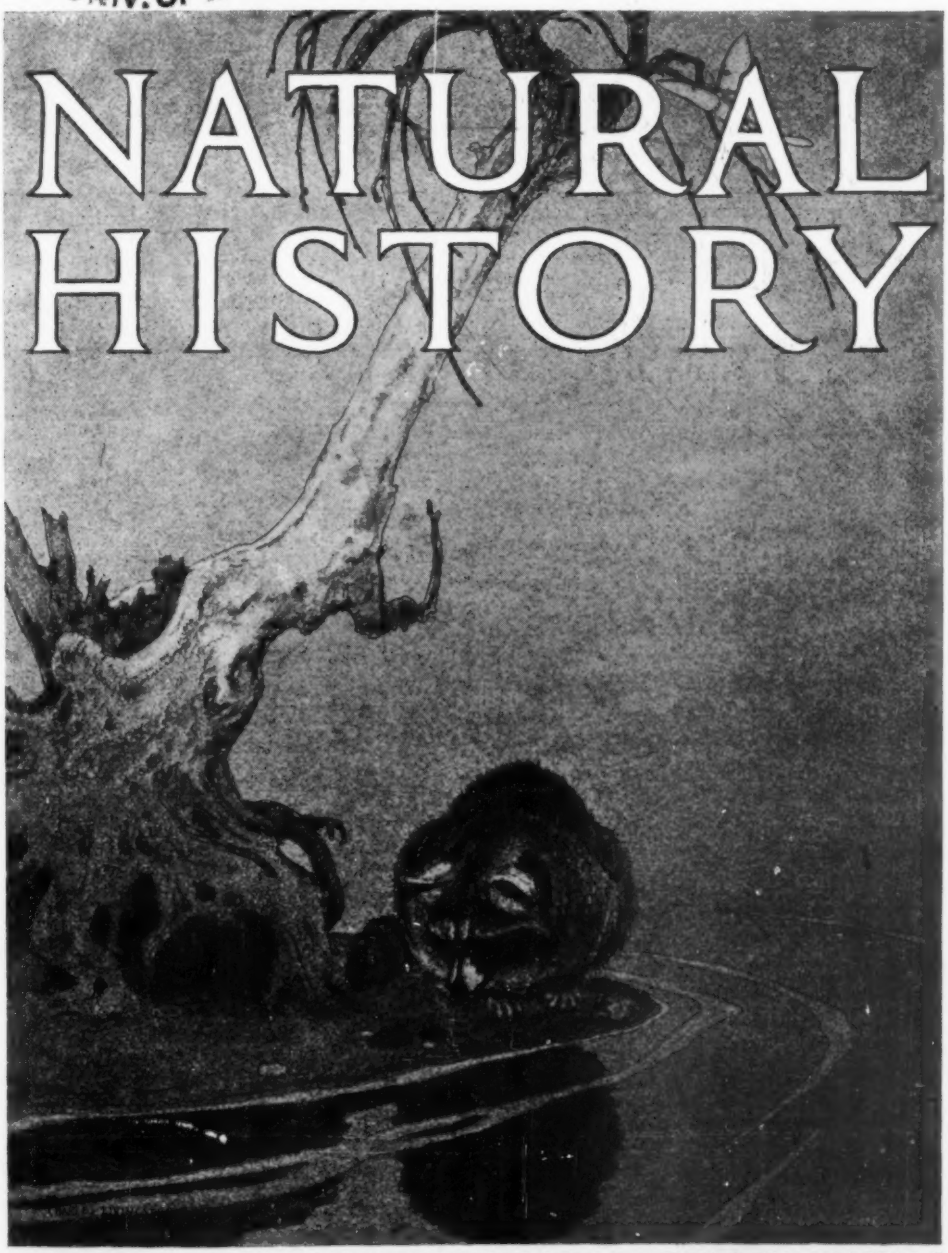
NATURAL HISTORY



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To my friend
President Henry Fairfield Osborn
from
Carl Lumholtz

NATURAL HISTORY

VOLUME XXI MAY–JUNE, 1921 NUMBER 3

MY LIFE OF EXPLORATION

BY

CARL LUMHOLTZ

FOREWORD.—In the accompanying pages we have a unique contribution from a man who is a charming writer and above all a great explorer. This autobiographical sketch was prepared at the request of NATURAL HISTORY and with a deal of modest embarrassment on the part of the author. Its charm lies in that in the writing of it Dr. Lumholtz took the same objective, discriminating view that characterizes his travel narratives. Later explorers following in his footsteps have often testified enthusiastically to the skill and exactness of Dr. Lumholtz in hitting upon the outstanding features of each new environment encountered and his ability to convey these snapshots to the reader with few words. One thus gets the feel of the country from the printed pages. So when one reads the following narrative he obtains in retrospect characteristic glimpses of a career occupied above all with five major expeditions, each of which has added greatly to our knowledge of the remote corners of the earth. The collections and data from two of these great expeditions were deposited in the American Museum. It has often been said that one of the greatest gifts and the rarest is the genius for exploration; however that may be, there can be no doubt as to the genius of Dr. Lumholtz.—CLARK WISSLER.

At school as a ten-year-old boy, I found the lessons about beasts and birds of the most absorbing interest. At that time not much attention was given to natural history in the schools of Norway and I was sorry after a short time to have to give up the study of animals for that of Latin and Greek. However, I later received some instruction in botany and learned how to collect plants, and during the last years of my school days I devoted almost every afternoon in the season to such collecting. In that way I made a fairly representative herbarium of the phanerogam flora of inland Norway, which some years later was presented to the Kew Gardens near London.

In taking my second degree at the University of Christiania I naturally chose the branches of natural science. I was particularly interested in zoölogy, which attracted me more than botany ever had. It was the desire of my father, who was a captain in the Norwegian army, to make a clergyman of me and, being of the old school, he did not see much value in the study of zoölogy. As theology did not appeal to me nor the position of clergyman in a state church barring the attractiveness of the farm with which he is provided, and as under such circumstances I could not make up my mind what course to pursue, I accepted a position as teacher in a private family in the country and continued in that capacity for over a year and a half. Finally I decided to meet my father's wishes and study theology. The great naturalist, Michael Sars, father of the present Prof. G. O. Sars, of the University of Christiania, was a country parson at the time he made his startling discoveries of animal life in the deep fjords of Norway and at times I thought perhaps there might be a similar opening for me, through the gates of theology, to cultivate what was according to my inclination.

I took my degree in theology but it had already become perfectly clear to my mind that I should never be a clergyman. To secure my degree I had had to work sixteen hours a day for several months; this strain brought on a nervous breakdown, which, however, unexpectedly turned to my benefit. To regain the stability of my nerves I now de-

voted myself exclusively to the collecting of birds and animals and to a study of their modes of life. The specimens secured I sent to the zoölogical museum of the University of Christiania and I always felt happy when Professor R. Collett's letters of acceptance arrived with some remarks about the specimens sent.

In the summer I made tours, always alone, up to the mountains in the central part of Norway, and how wonderful it seemed to be in touch with nature again! Never shall I forget how beautiful some clumps of small mountain willows looked one early morning as I passed through them in the enchanting summer light of the northern countries. After a rainy night, newly formed pools reflected the brilliant sunlight in which the leaves of the willows fairly seemed to sparkle. There was enrapturing freshness in the landscape, which was high above the usual abode of man. The beauty of nature took hold of me and I felt my freedom from the confinements of metaphysics and scholasticism. I was overcome by emotion and wept from joy.

The winter was no obstacle to my enthusiasm for zoölogy. The skiis, in themselves a wonderful stimulant to a love of nature, carried me far away into the hills and ranges surrounding Lillehammer, my native town in central Norway, famous for the natural beauty of its environment.

Love of nature took stronger and stronger hold of me and one day it occurred to me what a misfortune it would be to die without having seen the whole earth. I could hardly endure the thought which haunted me. There seemed very small prospect of my being able to realize my ambition because we were a large family and, although we were all very well brought up, my father had no fortune to speak of.

One day, however, Prof. R. Collett proposed to me that I should go to Australia to collect animals and birds for the zoölogical museum of the university. I was elated at this suggestion. It was arranged also that the various museums of the university make contributions toward the expenses of my proposed expedition. One of the best Norwegian sailing vessels, bound for South Australia with a lumber cargo, took me aboard as a guest, and after a hundred days of sailing we came to Adelaide. From here in due time I arrived at Gracemere, a cattle station near Rockhampton, Queensland, where the owners, Messrs. Archer, who were Norwegians of Scottish descent, had invited me to make my headquarters as long as I liked.

After I had collected at this station for a few months, an opportunity came to accompany a wagon driver who was going to take provisions four hundred miles inland to Minnie Downs Station, which my friends also owned, on the Barcoo River. Here I spent some time collecting. Not far from the house, in the dry creek, a certain fossil shell was found in abundance; it was a gigantic *Inoceramus* from the Cretaceous period and turned out to be a new species (*giganteous*).

Riding one horse and leading my pack horse I continued my journey alone westward to the Diamentina River, usually staying for a night at some sheep or cattle station, where hospitality is always extended to the traveler. I had a burning desire to continue the trip right to the Gulf of Carpentaria, but on the Diamentina River I contracted disagreeable wounds on the lower part of my legs, the result of bites inflicted by fleas living on the ground. This infection troubled me for several weeks, affecting my whole body, and finally obliged me to return to the coast.

Mr. Walter J. Scott, a great "squatter" whom I met in Brisbane, had been kind enough to invite me to stay at Herbert Vale, an abandoned cattle station which he owned on the Herbert River in Northeast Queensland, about 18 degrees south latitude. He had moved his station up to the highland

about a hundred miles westward, but good buildings had been erected at the original place and he had left an old man in charge. Here I might make my headquarters as long as I desired. It was a very tempting offer and, as soon as circumstances permitted, I found myself at the deserted cattle station on the Herbert River.

I at once sought the natives, who were prowling about in the neighborhood and who would come to the station every time we killed a bullock in order to secure the offal. These were so-called "civilized" blacks, that is to say, they had picked up a few words of English and had learned to smoke tobacco, of which these aborigines are inordinately fond; they were ambitious to secure such ornaments as a cast-off shirt or, better still, a hat,—to their mind the principal distinction between a white man and a black. These savages, with very few exceptions absolutely nude, who seemed to fit so well with their surroundings, at once attracted me, and on my daily excursions into the neighborhood, proved to be good companions.

The coast range not far away, at an elevation of four thousand feet, seemed always to beckon to me so invitingly; there ought to be rare, probably new, species of animal life in the dense jungle of that lonely range. But how to get there when the blacks of that region were reputed to be "bad"? After a while I decided on a bold undertaking, to camp and travel with these aborigines alone. I felt that surely they would help me to find animals hitherto unknown to science. As far as I know, no white man has ever attempted to camp alone with the wild natives of Australia; the first warning the colonists give you is, "Never have a black fellow behind you." My daring was, however, richly rewarded by the finding of new species of mammals, by the insight gained into the life of primitive man, and by the intense interest derived from real touch with nature.

Courtesy of Charles Scribner's Sons.

Native Australians from Northeast Queensland with their characteristic wooden clubs and shield. A wooden sword is on the ground

This sojourn for the better part of a year in the coast range near Herbert River became, in fact, the opening chapter of my life as an explorer. Thus far I had been a zoölogist. My life, however, among the blacks of Northeast Queensland awakened my interest in primitive man, and since then native races have been my life study.

From my headquarters I usually took along a dozen or more pieces of mildly salted and dried beef, some flour, and a small quantity of sugar, but as these provisions were quickly consumed because I was obliged to share them with my men, who were very fond of them, I also secured from my men the food that the natives use. There is a vine growing in that jungle that has a comparatively large root, which is excellent eating when roasted, but unfortunately it is rather rare. As for the rest of the vegetables that the blacks in those parts of the country use, they are very unattractive. Some of them in their natural state are actually poisonous, and have to undergo a process of heating and soaking in water before they may be eaten.

An Australian black fellow climbing a gum tree by the aid of a vine cut from the jungle. With the left hand he holds on to a notch in the vine and, after looping the tree with the free end, winds that end around his right arm. By flipping upward his rope-like support, he skilfully ascends

In respect to meat I was somewhat better off. The large lizards should not be despised, but the flesh of snakes was dry and practically unfit as food, though the liver is as pleasing to the taste as that of chicken. I often ate the animals and birds I skinned, but most of them were unpalatable. The meat of the tree kangaroo (*Dendrolagus lumholtzii*), which I had the pleasure of discovering, was, however, really attractive in taste, reminding one of game; this is very far from being the case with the meat of the ordinary kangaroo or of the wallaby. My favorite dish was the larva, eaten toasted, of a large brown beetle; the larva is found in decaying acacia trees. Contrary to what one expects the Australian native cooks his food well, and if there is the slightest indication of the meat smelling, he throws it away. He does not know the use of salt.

The curious "incubating" habit of the "brush turkey" (*talegalla*), which deposits its eggs in large mounds, there to be hatched by themselves, now and then offered us a chance of sitting down to a really good meal, for the eggs are large and very tasty. From the natives I learned the use of honey, which since then never has been missing on any of my expeditions. It makes a wholesome and pleasant drink and is rich in vitamines.

Every evening the blacks at my request made a hut of branches, which was rather low but long enough to enable me to stretch out at full length, an opportunity for relaxation which the natives are never particular about. If it looked like fine weather, my men did not even trouble to make any hut for themselves. Their one preparation for a comfortable rest was, by the aid of a stick and their fingers, to make a hole in the ground big enough to fit the hip. To keep warm in the night three or four would sometimes huddle together, absolutely nude and without any cover whatsoever.

A very important part of my outfit was tobacco, which served me instead

of money; for tobacco they would do anything. In Australia the "weed" imported from America could be purchased as plates of the strong "nigger-head" variety and, when about to be used, was broken up in sticks of the size of a finger. Clay pipes were also taken along, for the tobacco is never chewed by these natives. They were well satisfied with a small bit but had to be paid for any services, however trivial, that they did.

Next to tobacco my gun exercised great powers over them though I always had to bear in mind that missing my aim even once would mean a dangerous reaction in their estimate of the white man's superiority. During the latter part of my stay, whenever I found the behavior of my men less satisfactory, in the evening just before going to bed I would fire a shot from my revolver, which they called "the gun's baby" and for which they had a wholesome fear. It reminded them of my superiority. Not one word more was said. It was like my "good night" to them.

We naturally slept around the same fire, which at first they insisted upon making small in order that their enemies should not discover their whereabouts. It was a very fortunate circumstance for me that in the winter time when I began this camping life I used to feel cold at night in spite of the fact that I had brought along a blanket. I had to rouse my lazy black fellows and induce them to secure more wood for the fire. By being disturbed in this way they got it into their heads, as I later discovered, that the white man slept but little and always had the "baby" ready.

I had one friend among the savages, a young black fellow called Yokai, who took a singular interest in the white man, helped me to gather men for my expeditions, and evidenced a certain attachment to me. He loved tobacco and all the things I had seemed to interest him; nothing made him as happy as to be allowed to make *damper*, the bread of those who rough it in Australia, consisting of flour and water and cooked in the hot ashes. To him no doubt I owed my life, as he on one occasion said to me "it was no good killing the white man." He was remarkably naïve and often blurted out information about the other blacks which was of the greatest value to me. Nevertheless, I felt that if matters were brought to a crisis, I could not depend even upon him, for the Australian blacks are like big children. I never knew when he might be persuaded by his elders to allow them to kill me, which they most likely would have done by smashing my head with a stone during the night.

My little supply of tobacco, my shirts, and above all my white blanket were objects of envy to my men, and in consequence there was a constant temptation to kill their possessor. One reason why the blacks became very dangerous was that one of my own blacks had killed a lone white man who was attempting to reach the highland by walking. I exerted myself to have the murderer punished and the blacks all turned against me.

I always treated them justly and I did not feel called upon to shoot any of them; in fact, I have not as yet shot any man. My friend Yokai reproached me for being too kind. "You are not angry enough," he once said. "Shoot them, shoot plenty," he added.

There was nothing else to do but to return to civilization and I was truly glad when I arrived with all my collections at the sugar plantation on the lower part of the Herbert River. I had discovered, in addition to the tree kangaroo above mentioned, three other mammals. I was close on the track also of another animal, a large, carnivorous marsupial which the natives called *yarri*. This animal still awaits discovery. That it really exists I do not doubt, because in such matters the natives are to be depended upon.

The first three months of my camping

life with the natives of Australia are the most interesting, I might almost say fascinating, time I have had. I was then at the zenith of my power and it is, of course, pleasant to be the first, even among admiring savages. My whole sojourn, covering many months, with the men of the Stone Age was, however, an experience I am glad to have had.

The senses of the Australian blacks are superior to ours, their eyesight extraordinarily so. As he walks through the jungle, this savage man will constantly, without stopping, scoop up a handful of the soil and smell it, to ascertain whether some animal has passed that way or not. On the trunks of the trees there is always seen a bewildering number of claw marks left by different animals, for most of the animals of that region live in trees. He reads, as in an open book, what kind of animal ascended that tree the night before, and whether it is now up in the hollow of the trunk.

The most interesting scene I have witnessed during the many years spent with natives of different countries was the annual settlement of disputes, in use among the blacks of Herbert River. It is called *bórbobi* and is, in fact, dueling conducted on a large scale, several pairs fighting at the same time by throwing boomerangs and clubs, then spears, and ending by pounding each other with the heavy wooden swords used in Northeast Queensland. Huge shields are used for protection. On the occasion I attended one man was mortally wounded by a spear which actually went through the shield and into his stomach.

After having written a book on Australia[1] I went to the United States to lecture on my unusual experience and also with the hope of being given an opportunity to make researches among the primitive men of the American continent. My lectures created considerable interest and as early as the autumn of 1890 I was able to realize my project of exploring the northern part of the Sierra Madre, Mexico, conducting an expedition under the auspices of the American Museum of Natural History and the American Geographical Society. Professor W. Libbey of Princeton University joined the party and as we were about to enter a little-known region, I thought it advisable to take along a few collectors in the domain of natural history.

Starting from Bisbee, Arizona, in September, I entered Mexico through San Pedro, traveling in a southerly direction through Sonora and then turning eastward up into the Sierra Madre at Nacori. From here on to Casas Grandes in Chihuahua we had to make our own trail, which was done successfully in spite of the fact that it was winter and the size of my party considerable. With nearly a hundred animals—mules, donkeys, and horses—we crossed the Sierra Madre, at times camping in the snow. To this day our trail has remained the commercial road between the States of Sonora and Chihuahua.

Arriving at the Mormon colony, Pacheco, on the eastern slopes of the Sierra, we found some very interesting old cave dwellings to explore. Later on we settled on the lowlands of San Diego, where for many months excavations were made of several large mounds that covered house groups. We unearthed about five hundred pieces of beautiful pottery.

Among the fifty-five mammals secured on this first expedition to Mexico was a superb-looking red squirrel of the high Sierra, which received the name of *Sciurus apache*. Our botanical collectors, Messrs. C. V. Hartman and F. E. Lloyd, found themselves in a hitherto neglected field and their labors were rewarded with the finding of twenty-seven new

[1]An account of my Australian travels of four years was published in several languages,—the English edition *Among Cannibals*, by John Murray, London, 1889, followed a little later by the American edition, under the imprint of Charles Scribner's Sons, New York. The French edition, *Au Pays des Cannibals*, was published by Hachette et Cie, Paris.

Courtesy of Charles Scribner's Sons

Although the majority of the Tarahumare Indians live in simple shelters, usually made of rough pine boards leaning against each other, they all love caves. Many families go to the caves for a change of domicile, others live in them permanently. In fact, these Indians may properly be called the cave dwellers of the America of today

species of plants, some of them of much importance.

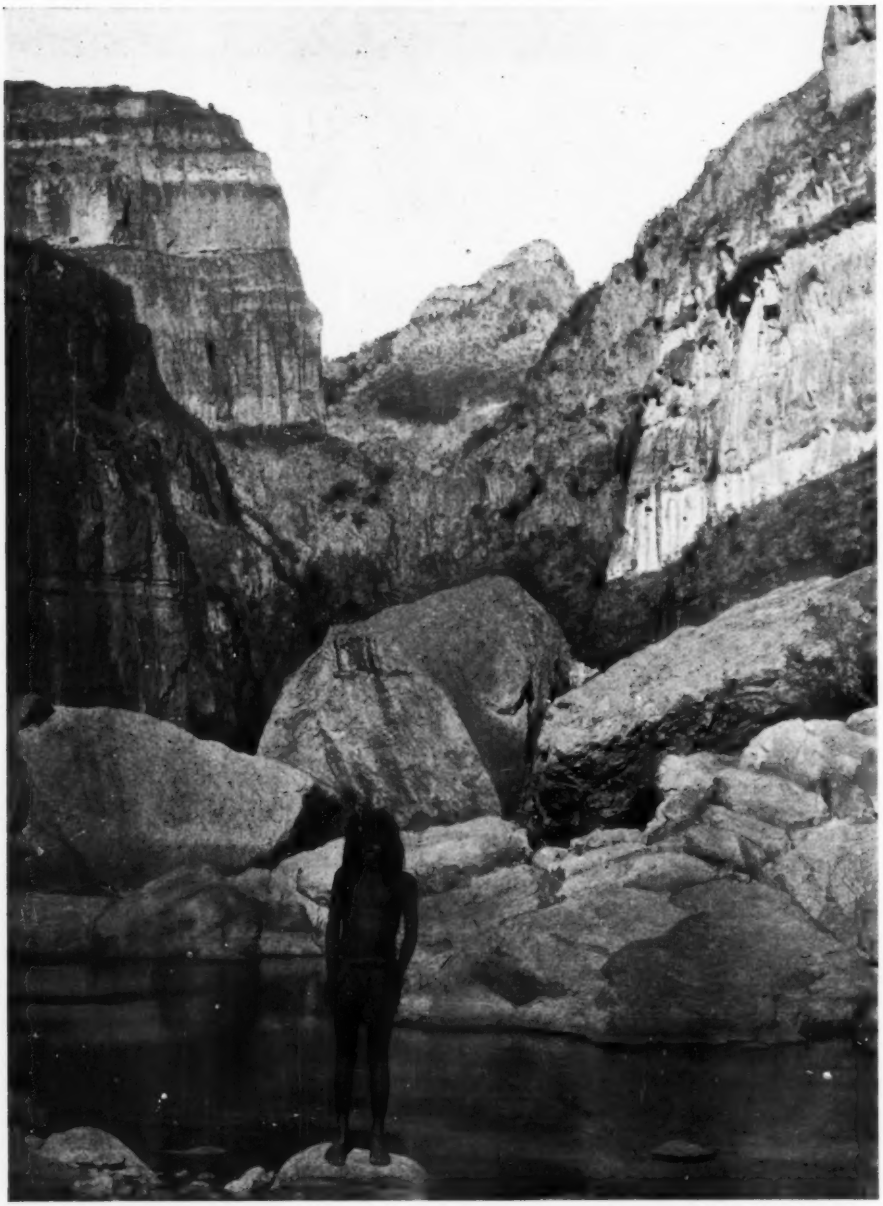
After an absence of some months in the United States I returned toward the end of the year to my camp at San Diego, and in January, 1892, with a much reduced force began my second expedition to Mexico, ascending again the Sierra Madre and following it southward.

At Tutuhuaca we met with a new species of pine (*Pinus lumholtzii*), which is very ornate on account of its slender, whiplike branches and its long, hanging needles. Later we often saw it growing in groups at high altitudes on decomposed volcanic tuff.

For one and one-half years I traveled in the extensive and picturesque country of the Tarahumare Indians, the great tribe of the State of Chihuahua. In order to save expense and to concentrate my efforts on ethnological research in the interesting region in which we found ourselves, I dispensed after a few months with my assistants, Mr. C. H. Taylor, civil engineer and photographer, and Mr. A. E. Meade, mineralogist. Mr. Hartman remained a few months longer as assistant in ethnology. Finally, however, I conducted my investigations alone, following the wild (so-called *gentiles*) Indians into the distant retreats in the deep cañons for which the States of Chihuahua and Durango are famous.

The Tarahumares are timid, honest, and bashful people, their habits and customs often being singularly interesting. Their dances, a kind of religious exercise, have been minutely described by me. A dancing place is found near all dwellings and on it is raised a small wooden cross to which to dance, and which represents a man with arms outstretched, Father Sun, the perfect man.

By selling most of my animals and a large part of my outfit and through the untiring efforts of two American ladies whose friendship I highly esteemed, I was enabled to continue these researches until August, 1893, when I took my Tarahumare and Tepehuane collections to Chicago and exhibited them at the World's Fair. Extensive vocabularies of the Tarahumare and Tepehuane languages as well as a vocabulary of the now almost extinct Tubares were among the results of this expedition, besides



Courtesy of Charles Scribner's Sons

BARRANCA DE SAN CARLOS IN CHIHUAHUA

It may be compared with the Grand Cañon of the Colorado so far as depth is concerned, and the sides are steeper, but the latter excels in extensive and picturesque views. The present picture, showing one of the author's carriers, a Tarahumare Indian, in the foreground, was taken in the upper part of the cañon, which is not as deep as the lower part

anthropological measurements, samples of hair, and osseous remains.

The great possibilities Mexico offers to ethnology proved an irresistible incentive to new researches, and seeing the results of my previous expeditions, the American Museum of Natural History of New York again sent me out on what was to be my third and most extensive Mexican expedition, lasting from March, 1894 to March, 1897. During these three years I again traveled alone, that is, without any scientific assistants. I had with me at first two or three Mexicans; soon, however, I found that my best companions were the so-called civilized Indians, or even Indians in their aboriginal state, who not only helped me by their mere presence to win the confidence of their tribesmen but also served me as subjects of observation. As before, I stopped for months with a tribe, discharging all alien attendants, and roughing it with the Indians. In this way I spent ten months among the Coras and Huichols. At first the natives persistently opposed me; for Indians are very distrustful of the white man, and no wonder, since he has left them little enough and they are therefore forced to guard that little the more vigilantly. I managed, however, to make my entry into their midst and gradually to gain their confidence and friendship, mainly through my ability to sing their native songs and by always treating them justly.

All along my route I gathered highly valuable material from the Tarahumares, the Northern and the Southern Tepehuanes, the Coras, the Huichols, and the Tepecanos,—all of which tribes except the last-named dwell within the Sierra Madre del Norte; also from the Nahuas on the western slopes of the Sierra, as well as from those in the States of Jalisco and Mexico; and, finally, from the Tarascos in the State of Michoacan. Of most of these tribes little more than their name was known, and I brought back large collections illustrating their ethnical and anthropological status, besides extensive information in regard to their

Huichols of the author's party crossing a swollen torrent on a bridge of their own construction

HUICHOL BOY

Raising maize and hunting the deer, as well as frequent participation in religious ceremonials, occupy the time of youths as well as men among this mountain people

customs, religion, traditions, and myths. I also completed my collection of vocabularies and aboriginal melodies.

Especially fruitful in results was my stay with the Huichol Indians. These Indians had been known mainly to a small number of Mexican half-breed traders and I was the first white man to visit them. The country was difficult of access and Mezquitic, the little town from which the tribe is reached, is distant three or four days' journey on muleback. The isolation of these Indians on a tall spur of the Sierra Madre had been their salvation and I found them living practically in the same state of culture as when Cortez put foot on American soil.

They had their temples and sacred caves, which were filled with symbolical objects of singular interest, thus throwing light not only on the cultural status of a barbarous tribe but even on that of their far more advanced kinsmen, the Aztecs. When my friend, that great ethnological genius, the late Frank Hamilton Cushing, saw the exhibition of my Huichol collection at the American Museum of Natural History, he exclaimed, as he let his eyes pass over the richly laden tables of the room: "This is like seeing a new species of man."

Of the ethnological results gained during my travels in Mexico I consider the information which was collected about the anciently well-known *peyote* (*lophophora*) among the most important. It is a well established fact that this little cactus when partaken of exhilarates the human system, allays all feeling of hunger and thirst, and produces color visions. In the Huichol tribe this highly interesting plant cult reached its greatest development. The Tarahumares also worship this plant.

In order to collect *hĭkuli*, as the cactus is called, a pilgrimage lasting forty-three days is annually undertaken into the State of San Luis Potosi.

Of late years the *hĭkuli* cult has, strangely enough, been adopted by certain tribes in the United States and well meaning people are trying to stop this on the ground that it is a kind of debauche. Nothing could be farther from the truth. By all manner of means prevent the Indians from getting the white man's brandy, which ultimately and surely ruins them, but *hĭkuli*, or *peyote*, is an entirely different matter.

As far as my experience goes, the partaking of *peyote* is not injurious to health; besides, the cult is observed only during a limited season of the year. The effect of the plant on the nervous system is very different from that of alcohol; the balance of the body is even better than

Courtesy of Charles Scribner's Sons

A flower (*Œnothera trichocalyx*) of the desert. It usually makes its appearance along the courses of the dried-up creeks

The author's pack train wending its way through the Sonora desert. The sand dunes owe their graceful outlines to the shaping force of the winds

under normal conditions. There is nothing vicious about the *hîkuli* cult. Abstinence from sexual intercourse is imposed on its devotees and a marked effect of the plant is temporarily to take away all sexual desire.

On my journey through the Tierra Caliente of the Territory of Tepic, and the States of Jalisco and Michoacan, I obtained a number of archæological objects of great historical value and importance. Among the antiquities secured may be mentioned a beautiful jar in the shape of a turkey, strikingly ornamented with thin gold plates. Furthermore, a number of large terra cotta figures were found in a subterranean chamber near Iztlan representing ancient Tarascan culture. About three hundred skulls of Mexican Indians were collected in the course of my first expeditions to the republic. These were all described years ago in a scholarly work by Dr. A. Hrdlicka. The publication of this important work has thus far been impossible through lack of funds but it is to be hoped that such funds may be provided for the purpose in a not distant future.

In 1898, accompanied by Dr. Hrdlicka, I revisited the Tarahumares and the Huichols. In 1905, I alone visited the Huichol and Tepecano Indians. My observations of the latter tribe have not yet been published.

In 1909–10 I made my last expedition to Mexico, traveling in the Sonora Desert and the southern part of Arizona, a fascinating country in spite of the arid conditions prevailing there. The wonderful colors of the late afternoon, the glorious sunshine, the peace and calm of night, and the thrills that accompany early dawn are sources of constant delight to the traveler. The extraordinary adaptations of plant and animal life, even the domestic animals of Indians and Mexicans subsisting without difficulty for months without water, cannot fail to interest the observer. With the exception of the Seri and the Pima Indians, the natives of the desert had so far received little attention from those engaged in the study of primitive races. The Papago are the great desert people of America and are remarkably stable in their racial characteristics, still preserving the traditions and habits of the past, which soon will disappear.

I was fortunate in being able to describe their harvest festival and in other ways to give an insight into their

A drinking pool in the Sonora desert. In the cavernous depressions, known as *tinajas*, of the lava formations, water is also obtained

tribal life. It is well authenticated that the tribe knows a cure for hydrophobia and, in order that the secret shall not die with the tribe, I may take this occasion to state that the main ingredients of the medicine are certain excrescences, of wonderful antiseptic quality, found on the greasewood (*Covillea tridentata*), the humble but very attractive bush of the desert.

My researches in Mexico and the Southwest, extending from Casa Grande, Arizona, down to west of the City of Mexico, thus covered a period of nearly eight years, six and a half of which were spent among the Indians of those regions.[1]

Ever since my adventurous life among the blacks of Northeast Queensland it had been my desire to explore New Guinea, the largest island on the globe, and among the least known regions thereof. In 1914 it really seemed that I was on the point of realizing the dream of my youth. I found myself in Batavia, Java, about ready for the start eastward to New Guinea. It was a Norwegian Expedition, which had the support of their Majesties, the King and the Queen of Norway; the Norwegian Geographical Society, the Royal Geographical Society of London, and the Royal Netherlands Geographical Society, each made a contribution to my funds, which, besides, were increased by American and English friends. With the outbreak of the great war, however, my plans suddenly had to be changed. His Excellency, the Governor General of the Dutch Indies, Mr. A. W. F. Idenburg, regretted his inability to give me a military escort and other assistance for carrying out my plans, and advised me to await a more favorable opportunity. As I had never been in British India, I decided to go there while awaiting developments. In India I studied Hindu religions, a fascinating occupation, but after eight months spent there I decided to return to the Dutch Indies and undertake an expedition to Central Borneo, parts of which are unexplored and un-

[1]My publications on Mexico are, besides minor articles:

Unknown Mexico, in 2 vols, illustrated, Charles Scribner's Sons, New York, 1902.

New Trails in Mexico, illustrated, Charles Scribner's Sons, New York, 1912.

Symbolism of the Huichol Indians, Memoirs of the American Museum of Natural History, 1900.

Decorative Art of the Huichol Indians, Memoirs of the American Museum of Natural History, 1904.

Courtesy of Charles Scribner's Sons

The floor of the desert sometimes rivals the "ribbed sea sand" in its minute sculpturing. Such wavy lines owe their origin to the action of the wind. The scene is of the desert northwest of Pozo del Caballo, Sonora

known to the outside world. The Governor General with the greatest courtesy assisted me in furthering my project, and gave me a small escort of six Javanese soldiers under the command of a Dutch lieutenant. An excellent native surveyor was attached to the expedition and for part of the time one of the government's photographers.

The journey through central Borneo, which consumed nine months, was successfully made. There are no roads in Borneo, all communications being by water, the large rivers enabling the traveler to ascend far inland. Numerous rapids, often very difficult to conquer, have to be passed. In the central part of the great island, the absence of life—in other parts abundant—was very striking. The only birds that you might hear or see were the great hornbill, the sandpiper, and a kind of kingfisher. No more fish were caught in the rivers; there were not even mosquitoes, hence there is no malaria in the interior. As for human beings, large tracts of the inland country are uninhabited.

There was no change, however, in the exuberant richness of the tropical vegetation. As we ascended the Upper Busang River, the scenery was often beautiful beyond words; silence reigned supreme. It was like having a pleasant dream.

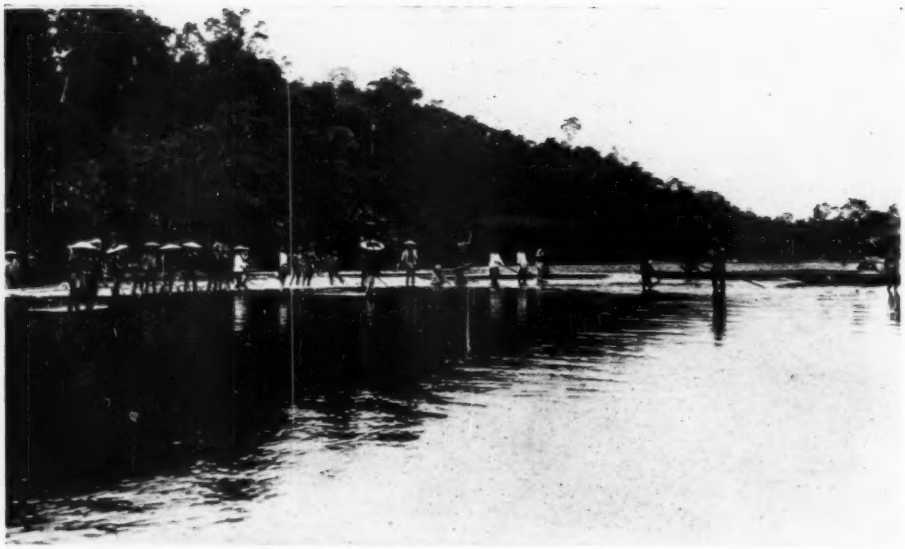
I extended my travels to other parts of the great island and thus spent the better part of two years among its very interesting natives. They form many different tribes, which, however, present many similarities and are therefore included under the general name of Dayaks. Some of the tribes I met with had never been studied before. I may, perhaps, not be accused of being immodest in claiming the credit for having been able to put the head hunters of Borneo in the right light before the civilized world.

My researches prove that this very repulsive and extraordinary custom of taking heads is not due to particular viciousness on the part of those who practise it, but has its foundation in their vivid realization of a life after this; in fact, to the Dayaks, as to many Oriental people, there is no essential difference between this life and the next.

At the very moment that a Dayak cuts off the head of a man belonging to another tribe, his soul conquers that of the departed, who becomes his slave. If that head, or in other words the soul residing in it, is treated well, it becomes a friend and guardian of the tribe. Such a head protects against the evil spirits and even insures material benefit. This is in a few words the idea underlying head hunting.

An important medicine man of the Huichols and his wife. Girdles and pouches like those worn by the man are woven by the women, the designs often being astonishingly artistic. The pouches are for ornament, not for use. The object on the head of the man is not a cap but a woven ribbon used for binding the hair

A medicine man of the Huichols beating his deer-skin-covered drum. The drum plays an important part in many of the ceremonies of this people. The curious easy-chair in which he is seated is of native manufacture and is reserved for the important members of the tribe, such as temple officials and medicine men



Farther up the river men of the Kenyah tribe of Borneo have been beating the roots of the *tuba* vine to free the poisonous juices therein contained. These juices, mingling with the waters, stupify the fish and thus make possible their capture. In the picture women of the tribe are seen with hand nets held in readiness to scoop up the fish that are being carried along helpless in the current

Sections of bamboo stalks are used as containers for rice or for pork, important items in the diet of the Dayaks. A little water is added but no salt. As long as the stalks are green, they resist burning. Rice cooked in this way has a sweet, delicious flavor

The long-nosed monkey (*nasalis larvatus*) is peculiar to Borneo. These creatures are sometimes found in groups of a hundred or more travelling through the forest by swinging from branch to branch

These " wild men of Borneo" neither tell lies nor steal. To appropriate the property of another is a thing they take good care not to do, for a thief in the next life will be seen carrying around on his back all the stolen goods, thus exposing himself to ridicule and contempt. The Dayaks are hospitable, generous, and loyal. During the two years I traveled among them I never once observed children quarreling or fighting.

The results of my journey were very satisfactory. Vocabularies of many tribes were studied and collected; anthropometric measurements were taken and much new information gathered about the habits and customs of the natives. I brought back material for several treatises, especially in regard to the decorative art of the Dayaks and also concerning a much developed protective system which certain tribes possess in carved wooden figures called *kapatongs*.

Skins of mammals and birds were secured, as well as specimens of fishes and reptiles in alcohol. So far only the mammals have been examined; these yielded one new species and two new subspecies.

It is a curious fact that both among the Chinese and the Malays individuals are met with who are thoroughly convinced of the existence of brown men with short tails. Many will tell you that they themselves have seen them. I was able to collect from the Dayaks the legend of the tailed men, which may be found in my book on Borneo.[1]

The Great Archipelago in which I found such a remunerative field for my efforts appeals to me more than any other part of the earth which I have visited. In its humid and warm climate I thrived, feeling, in fact, better there than here. The great possibilities of discovery in those distant islands fascinate me now as they did when I

Courtesy of Charles Scribner's Sons

The Manx cat is not the only one with a rudimentary tail. In Borneo there is a domestic feline that is either stub-tailed or with a ball at the end of its exceptionally short caudal appendage

was in Australia. I have decided to devote the rest of my life to science, to visit little known or unknown parts of the earth with the hope of increasing our knowledge from a geographical and anthropological point

[1]An account of my exploration of Borneo is given in *Through Central Borneo—Two Years' Travel in the Land of the Head Hunters*, Charles Scribner's Sons, New York, 1920.

From a cinematograph showing a Penyahbong of Central Borneo gracefully executing a war dance practised by many Dayak tribes. Before seizing his sword and shield and indulging in the more violent movements of the dance, he went through the preliminary of exercising all his flexible muscles. His motions were lithe as those of a serpent

of view and also with the expectation of making further contributions in the field of natural history.

I am more than ever interested in carrying out my New Guinea project, which was so unexpectedly thwarted by the outbreak of the war. No country offers such rewards to the intrepid explorer as New Guinea, the largest island on the globe, lying just to the north of Australia with which it was once connected.

In 1920 I went abroad in the hope of securing in Norway the necessary funds for this the greatest of all my undertakings. If I had come one year earlier, I should have gotten all the money needed, and more, my friends assured me, but the great financial depression which had then begun to manifest itself in Norway made it impossible to secure more than a small part of what was needed. It must be said that my countrymen did all that they could to further my purpose in which they are intensely interested, but "*Ultra posse nemo obligatur.*"

I am now trying to get the necessary support in the United States for an enterprise that cannot fail to give the valuable results desired and which may prove of direct benefit to civilization by the discoveries I expect to make. This is not the place for a detailed account of my plans, which I shall always be most happy to furnish to anyone interested in the matter, but may I not be allowed in a few words to state the object of my proposed expedition?

I intend to cross New Guinea from south to north at its broadest point, having chosen a route where no white man has ever been before me. We shall have to cross at an elevation of 10,000 feet the great Snowy Range, whose highest measured peak is 18,000 feet. From the time when I shall have established my headquarters at the foot of the range until I am able to emerge on the north coast of the island, one year will have elapsed. The backbone of

The artistic ability of the Dayaks expresses itself in carving rather than in music. Nevertheless, they have musical instruments, the chief of which is here represented. Its notes are rather pleasant

my expedition will be 175 Dayaks, who will be brought to New Guinea from Borneo. They are to be our carriers, builders of boats and of houses. I shall have two taxidermists and a botanical collector; an experienced geologist, whom I hope to secure in the United States, will be an important member, for this great island is of particular interest to geology, which here will find the solution of many of its most important problems.

For many years I have studied the food question, and there need be no fear that beri beri or kindred diseases will attack the expedition.

Among people who know, it is the universal verdict that no region offers such inducements for exploration as New Guinea. We expect to meet natives that have never seen a white man. Whenever a collector has gone up a hitherto unvisited river in New Guinea, he has invariably brought back new species of birds of paradise, and without any doubt we, too, will discover new species of these most gorgeous creatures. We are confident, too, of coming upon new species of mammals, some, maybe, of considerable size. Superb butterflies and interesting land shells may be expected. Botany will naturally gain much that is novel. In geology, specially valuable results may be anticipated, and we are likely to find new minerals.

Thus we may hope to make a valuable contribution to the history of the earth, as well as to our present knowledge of the mineral, plant, and animal kingdoms. Some of our discoveries may even prove of great economic value.

A tame horn-bill that often came to roost on the author's tent. The Dayaks refrained from laughter, no matter how ridiculous were the antics of this bird, for they hold the belief that those who laugh at animals will be stricken with illness

HEADS OF AFRICAN ELEPHANTS

DISPARITY IN SIZE BETWEEN THAT OF THE MALE AND THAT OF THE FEMALE

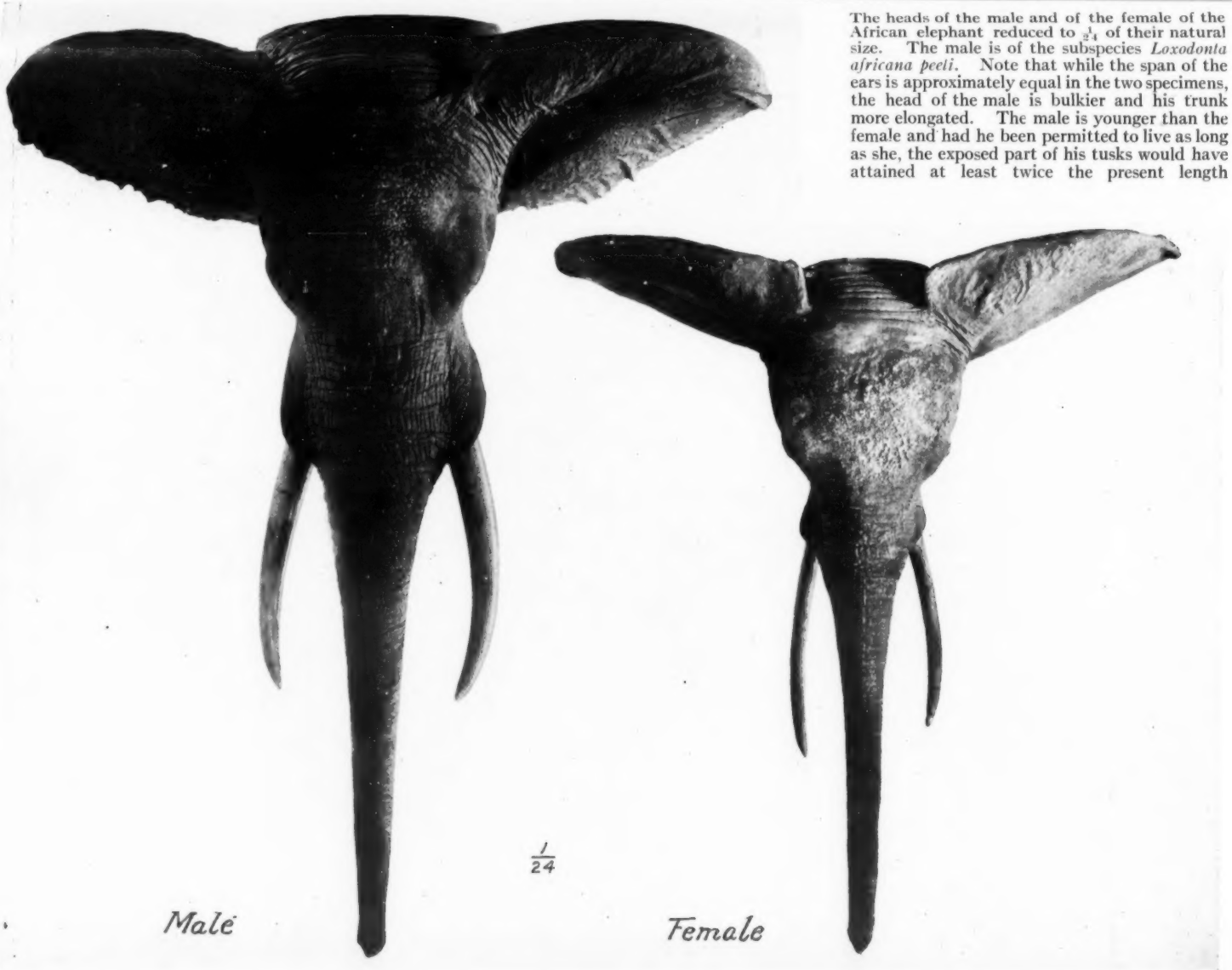
BY

HENRY FAIRFIELD OSBORN

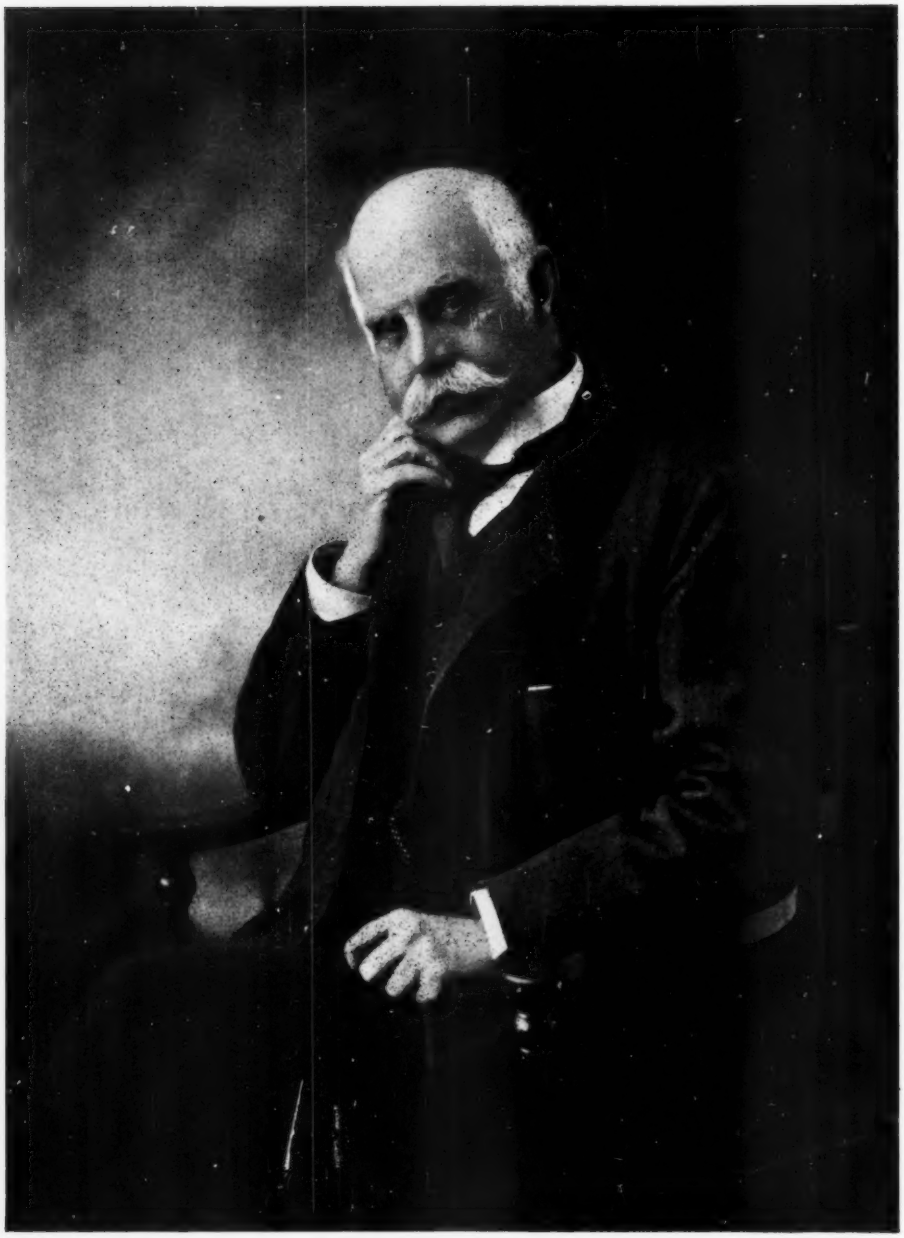
IN recent studies of the Proboscidea, living and extinct, I have been very much impressed with the marked contrast between the males and the females throughout the whole period of their evolution. This, in fact, has attracted the attention of observers from early times. The disparity in size between the sexes appears to be even greater than among other ungulates. For purposes of comparing the head in the two sexes, I have recently had photographed from above two superb heads in the American Museum. The male belongs to the subspecies *Loxodonta africana peeli*. It was obtained in northern Uganda in the year 1911 by Mr. Carl E. Akeley, and was chosen as the typical bull for his African Elephant Group, which is nearing completion. It is shown in the accompanying photograph, $\frac{1}{24}$ natural size. Photographed to the same scale is the head of a female. This specimen belongs to Mr. Paul J. Rainey, who collected it north of Mt. Kenia, and is regarded as a record female in weight and in length of tusks. It will be observed that the tusks of the female, while extremely slender, are almost as long as those of the male. The spread of the ears is almost equally great, but there is a marked disparity in the size of the head, also of the proboscis. The exact proportions have not been established, but it would appear that the head of the female is not two-thirds the mass of that of the male. Closely similar disparity is found in the American mastodon, of which the American Museum collection contains fine examples of both sexes. The tusks of the female of the mastodon are equally slender.

In commenting on the relative size of the tusks of these two heads Mr. Carl E. Akeley reminds us that the cow is very old and the tusks have reached practically their limit of size, whereas the bull is young, under thirty-five years, and, barring accidents, had he lived to the age of the cow, his tusks would have been at least twice as long as they now are—that is, the exposed portion of the tusk. The proportionate size of the ears varies greatly in individual elephants. These remarks apply in less degree to the relative size of the skull in male and female African elephants, which is probably fairly shown in these photographs.

Apropos of the condition of the tusks in the female, Mr. Haagner writes from South Africa that many of the females in the Addo herd, which has recently been nearly exterminated, are without tusks. The deliberate decimating of this herd in South Africa is the latest episode in the long history of crimes committed by man in the world of mammalian life. In a single shoot, under pretense of protecting the crops and of keeping down the nagana disease, the herd was reduced from one hundred to sixteen. While the government has stepped in to prevent further killing, it is doubtful whether this small herd of sixteen, which is all that remains of the vast numbers that roamed over southern Africa in former times, will be of sufficient size to preserve this southern species from extinction.



The heads of the male and of the female of the African elephant reduced to $\frac{1}{24}$ of their natural size. The male is of the subspecies *Loxodonta africana peeli*. Note that while the span of the ears is approximately equal in the two specimens, the head of the male is bulkier and his trunk more elongated. The male is younger than the female and had he been permitted to live as long as she, the exposed part of his tusks would have attained at least twice the present length



MAJOR LEONARD DARWIN

Because of his untiring devotion to the cause of eugenics and his eminent accomplishments in furthering that cause Major Darwin's selection for the delivery of the opening address at the Congress of Eugenics, to be held at the American Museum, September 22-28, is one that cannot fail to command wide approval

THE SECOND INTERNATIONAL CONGRESS OF EUGENICS

OF transcendent importance will be the Second International Congress of Eugenics, which is to be held in the American Museum of Natural History, September 22–28, nine years after the First Eugenics Congress, which assembled in London. There is no subject so vital to human welfare and to the ultimate destiny of mankind. The great war has taken an appalling toll of the best stock of each nation; it has spared many less desirable types. Those whom the draft found unfit and who, through the immunity thus enjoyed, are relatively a larger element in the population than before, will have their part, a disproportionate part, in fixing the physical and mental types of the generations that are to succeed. All important, therefore, is a congress such as the one that will gather, for only through the interchange of thought among those who have given intensive study to the subject can light be thrown on the question of racial improvement.

The Congress will open in the new Hall of the Age of Man on Thursday evening, September 22. President Osborn of the American Museum will preside and give the address of welcome. Major Leonard Darwin, President of the Eugenics Education Society of Great Britain and Presiding Officer at the First Eugenics Congress, will deliver the opening address on the history of the eugenic movement from its institution by Francis Galton. Dr. Charles P. Davenport, the present leader of the eugenics movement in America, will review the progress which has been made in America and will outline the program of the Second Congress.

The comprehensiveness of the proposed program is indicated by the fact that it is divided, according to subject matter, into four sections. The leading address of Section I will be given by Dr. Lucien Cuénot, of Nancy, France, one of the great students of heredity, whose researches among the lower organisms have enriched science. This section will occupy itself with the results, on the one hand, of investigations in the domain of pure genetics in animals and plants and, on the other, of studies in human heredity. The application to man of the laws of heredity and the physiology of reproduction, as worked out in the case of some of the lower animals, will be presented.

Dr. Herman B. Lundborg, of the University of Uppsala, Sweden, an authority on psychiatry and neurology and widely known for his painstaking study of disease as a factor in heredity, will deliver the leading address in Section II. Dr. Lundborg, conducting an investigation similar to that made by Dugdale of "The Jukes," examined the records of several thousand individuals of a Swedish family of unfortunate heredity extending over a period of some two hundred years. The investigation has been characterized as "the most comprehensive and thorough examination of a family that has ever been made." Section II will weigh the factors which influence the human family. First among the agencies for the improvement of the race is a proper understanding of the significance of marriage. Those who enter into such a union should appreciate the fact that it involves in most cases the destiny of other lives, in addition to those of the contracting parties. A knowledge of the significant family traits of which each of the parties to the proposed marriage is the bearer and the method of inheritance of these traits should, no less than natural sentiment, govern those who would wed. In this connection will be brought forward data bearing upon improved and unimproved families and showing the persistence, generation after generation, of the best as well as the worst characteristics.

The fecundity of different strains and

the application of social and legal controls in the case of strains that are undesirable is a subject deserving the painstaking consideration it will receive. Phases of this question are the undue postponement of marriage and the restriction of the birth-rate among those often best fitted to transmit their characteristics to the next generation, and the unrestrained assumption of parenthood by inferior stocks. The effect of war, epidemics, and endemic diseases upon different elements of the population, resulting in a differential mortality among the eugenically superior and inferior will receive due emphasis.

Dr. V. de Lapouge, of Poitiers, France, author of *The Fundamental Laws of Anthropo-sociology*, *The Social Rôle of the Aryan*, and other noteworthy volumes, whose race studies have yielded important results, will present the leading address in Section III. This section will concern itself with the topic of racial differences and their significance. It is the popular tendency to confuse race with nationality. Political boundaries and differences of language do not constitute differences of race. Indeed, within a single nation there may be several racial strains,—France, for instance, furnishing Nordic, Alpine, and Mediterranean types as one travels from north to south. The migration of races, the influence of racial characteristics on human history, the teachings of the past in their bearings on the policies of the future will receive attention in this section. Certain prejudices directed toward existing races will be dispelled when allowance is made for the influence of their social and educational environment, and their fundamentally sound and strong racial characteristics are brought to light. On the other hand, it will be shown that the development of certain races has limits that cannot be passed and that it is futile, therefore, to try through education and environment to change their fundamental characteristics. Consideration of the advantages and disadvantages involved in the mingling of races and of unions that have proved fateful to social progress, falls within the sphere of this section. Differences in racial resistance to disease will also be discussed.

Section IV, dealing with applied eugenics, is of culminating importance. The leading address in this section will be delivered by Major Leonard Darwin, one of the sons of Charles Darwin, and himself distinguished for notable achievements in more fields than one. Born in 1850, he was educated at the Royal Military Academy, Woolwich, and in his subsequent career in the Army served for five years on the Staff, Intelligence Department, War Office. He was a member of several scientific expeditions; he has served in Parliament. Among the offices which at one time or another he has held are: President of the Royal Geographical Society; Chairman of the Professional Classes, War Relief Council. Since 1913 he has been Chairman of the Bedford College for Women, University of London. He is President of the Eugenics Education Society and presided at the First Eugenics Congress in 1912. Section IV will discuss eugenics in relation to the state, to society, and to education, and will bring the subject to bear on the various social problems and movements of the day. "Eugenics in International Affairs," "Some Eugenic Aspects of the Problem of Population," "Educability and Inheritance"—titles which appear among the announced addresses for this section—indicate to some extent its scope and purpose.

About sixty scientists from all parts of the world have already arranged to give addresses on different phases of eugenics. It is anticipated that the number of papers will far exceed the opportunity of their presentation. A large number of scientific bodies and institutions, some as remotely situated as the University of Punjab, India, have signified their intention to send delegates.

Efforts are being made to raise funds to bring from Europe and remote parts of the Americas the most representative workers in the field of Eugenics. An opportunity is offered for those interested to become patrons of the Congress by subscribing $500 each, to be expended for this purpose. The Carnegie Institution has made a grant of $2,000 toward the entertainment of the delegates to the Congress and toward the expenses of certain European scientists. The following organization and individuals are already enrolled as patrons: Race Betterment Foundation (through Dr. John H. Kellogg), Charles K. Gould, Archer M. Huntington, Cleveland H. Dodge, Mrs. Worthan James. For the purpose of the Eugenics Exhibition, allusion to which was made in the March-April issue of NATURAL HISTORY (p. 206), Mrs. E. H. Harriman has contributed $2,500.

There are two classes of members, sustaining members and active members. Sustaining members will have the privilege of attending all sessions and gatherings of the Congress and they will receive bound copies of the Proceedings of the Congress. Their names will appear as sustaining members on programs and in all permanent publications of the Congress. Dues for this membership are $100. Active members will have the privilege of attending all sessions of the Congress. They will be enrolled as Active Members and will receive a certificate of membership. Dues, $5.00.

For any information concerning the Congress, address Dr. C. C. Little, Secretary-General, American Museum of Natural History, 77 Street and Central Park West, New York City.

Though the American Museum will be the center of activity of the Congress, visits are planned also to other places. On September 25 an excursion will be made to Castle Rock, the residence of President Henry Fairfield Osborn of the American Museum. On September 28 a trip is planned to Cold Spring Harbor, Long Island, where the Congress will be welcomed by the department of genetics of the Station for Experimental Evolution, Carnegie Institution of Washington.

As a result of the views interchanged during its sessions, the Congress will undoubtedly on disbanding disseminate a great many constructive suggestions, the adoption of which should tend to elevate humanity and bring into the range of vision the goal toward which it is striving. When one thinks of the staggering public burden that is being carried because of the existence in the populace of elements that on account of inherent incapacity or depravity can never be other than a drag upon their fellows and a source of irritation to themselves, it would seem that any gathering looking seriously to the ultimate correction of such evils and to the establishment of better ideals of life could not fail to win the support of all thinking men.

MUSSEN MOUNTAIN

A portion of this impressive mountain—a temptation to the climber, who is rewarded by the splendid view obtainable from its summit—is here shown. The south end of Bold Bluff occupies the right of the picture. Toward the left center is High Falls, a nearer view of which is obtained in the illustration on page 255

THE CORDILLERAN ICE SHEET*

BY
L. C. READ

THE Cascadian region cannot fail to inspire with enthusiasm the student of glaciers and glacial action, for it was the seat of the great Cordilleran ice sheet of Pleistocene times. There is abundant evidence that the region was covered, over an extent of hundreds of miles, by superincumbent ice thousands of feet in thickness. The ice must necessarily have been of great depth to flow to termini as distant as those which the evidence postulates.

On the east, the Cordilleran coalesced with the Keewatin ice sheet in the region of the Rocky Mountains. In the north, it evidently flowed far toward the Arctic via the Yukon River, but in a much thinner sheet than to the west and south. The evidence seems to be conclusive that the ice flow extended south into the state of Washington some eight hundred miles distant and even reached Idaho and Montana.

Given a grade of but twenty feet to the mile, the ice must have been sixteen thousand feet above sea level to have arrived at its termini. To the west—where one is filled with wonder at the mighty work accomplished—the ice had to traverse less than one hundred miles to reach the sea. Even if the grade was much greater in that direction, the ice must have been thousands of feet deep as it shoved its way far out into the Pacific to the point where the bergs tore themselves free from the parent field.

These stupendous bergs may have circled for a time in an eddy of the great Gulf of Alaska, swinging in a mighty orbit to the diapason of Old Ocean, before starting south to tropical waters, there to be dissipated. Grinding, jostling, pushing one another, turning somersaults, scintillating prismatic colors of great beauty and mammoth design, slicing off protruding promontories here and there from the shore, sometimes grounding and massing the whole parade, ploughing the succession of great fiords that constitute the famous "Inside Passage" to Alaska, reshaping the whole Pacific coast line for a thousand miles,—such must have been the stupendous scene that was enacted where the opposing forces of the Japan Current met the cold air and waters of the North Pacific, unfortunately for us before man had a written language.

If we take Surprise Lake, twelve miles east of Atlin Lake, as the névé or dome of alimentation (which seems but reasonable as it is the highest lake of any size in the region), we shall find a recession of altitudes in every direction for many miles; but as we arrive at the periphery, we notice a very marked increase in elevations. This leads one to suspect that before glaciation the head waters of the Yukon were much higher than at present.

The study of the rivers and mountain ranges discloses the mighty struggle Mother Earth had with this great protuberance of ice upon her breast. Depression must have occurred; then after the ice receded, an effort at readjustment came into play, which may be, probably is, proceeding at the present time.

The rivers and creeks seem to be searching, almost in vain, for a feasible route to the sea,—they evidence a lack of decision that is quite noticeable. Sloko Lake is but two and one half miles from Atlin Lake to the south, but is some two hundred and fifty feet higher. At one time it drained into Atlin Lake; later the outlet was filled with morainic deposition and its course changed in consequence. The outlet at present follows an erratic course, first moving to the east, then bending to the south and west, finally joining Taku River and emptying into the Pacific, thus in its later stage reversing the direction it had originally taken.

The present front of Llewellyn Glacier is about two miles from the shore of Lake Atlin and near its southern end. The average rate of recession seems to be about twenty feet per annum. If this has been constant, the ice left the shore of the lake more than five hundred years ago, and the north end of the lake, some twenty-three thousand years ago,—a calculation which corresponds very well with estimates as to the beginning of the post-glacial period. If conditions remain the same, recession should be completed in about ten thousand years, when there will be discoverable hardly a remnant of the present glaciation.

There are few real glaciers of good size more easily accessible than these of the Cascadian region, if one knows the routes to pursue. And yet, probably the most readily attainable one of all, Llewellyn, is coyly hidden amidst the wilds of northern British Columbia, in a practically new and wild region.

To visit Llewellyn Glacier, we disembark from the boat at Glacier Bay, and an easy walk of two and a half miles by wooded trail and terminal moraine takes us to the face of the ice. A few minutes' climb over morainic débris lands the aspirant on the ice. Women, and sometimes men, hesitate at this point, thinking of crevasse, moulin, bergschrund, and other dangers that may confront the climber, as the guide assists in adjusting "ice creepers" and runs out the long rope that all may have something to hang on to, while traversing the first two hundred yards to the more nearly level ice field above. When this is attained, the rope is coiled up and every one is at liberty to traverse at will the nearly level ice plain, which is many miles in extent.

On the right is the wreck of the great ice arch of 1919, illustrated on page 617 of the December, 1919, issue of NATURAL HISTORY. Only the abutments are left now, covered with gravel. No one would suspect the structure had ever existed except for the photograph and background. High above the remains of the arch, in all their majesty, rise the snow-covered peaks of Mussen Mountain, which is a long range extending south well into the ice field. It was from the southern peak of this mountain that the panorama photograph of the northeastern portion of the névé (p. 614, NATURAL HISTORY, December, 1919) was taken, August 10, 1918.

In a southern direction the seracs (ice pinnacles) are several miles away; nevertheless, many people make a start for them, not realizing the distance. The thirsty climber eagerly drinks the clear, cold ice water found running in pretty, ice-blue rivulets on the surface and disappearing in crevasses or moulins of great depth and loveliness.

On the left, about a mile distant, the wide, fan-shaped medial moraine is slowly coasting along on top of—and quite a bit above—the otherwise smooth surface, to its destiny as an addition to the ground moraine, thence to be scattered, sooner or later, by the streams flowing into Glacier Bay, silt-coloring that body of water for miles before sinking.

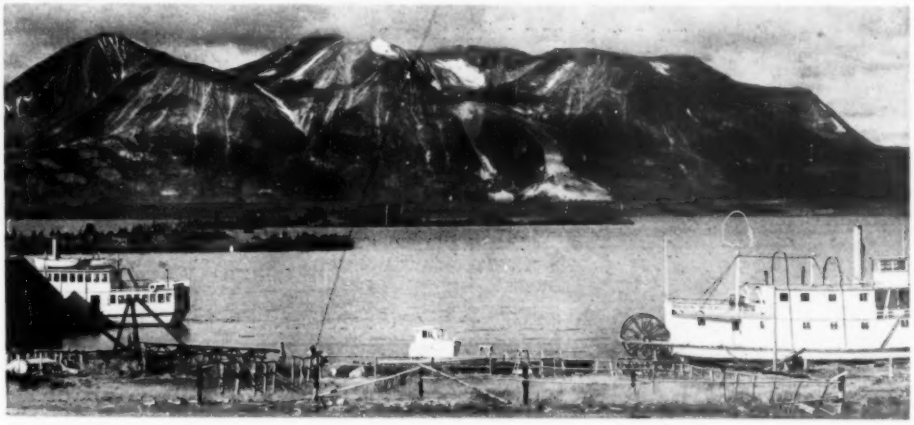
Beyond the medial moraine towers the precipitous face of Tsatia (an Indian name meaning rocky mountain), with Sloko Range beyond, ten to twenty miles away. To the right of Tsatia and several miles away, Llewellyn Mountain, a giant nunatak, with its sharp peaks, cirques, and beautiful, cascading glaciers, is bound to bring into requisition one's binoculars, with a sigh over the fact that it is too far away for a climb unless one is prepared to camp out a night or two.

You look down into a crevasse or moulin and discover that you not only cannot see the bottom, but that you cannot even hear the chunks of ice you throw down strike the bottom. Then you realize that the ice is several hundred feet deep where you are standing; and then, perhaps, you may feel a slight jar

under foot, coupled with uncanny grinding and creaking, and horrible dæmon groans sounding up from dungeon depths below,—and you take a more or less hurried leave for *terra firma*.

But you want to go to those seracs. If you are a good walker, take a lunch with you and make an early start. After visiting the seracs you may climb the south peak of Mussen for the view of the névé, which is hidden by the seracs although it is about six thousand feet above sea level. With creepers you can descend safely to the bergschrund, taking care to find a solid carapace on which to leave the ice and ascend the mountain. The higher you go, the more vast and grand is the view, and you feel well repaid even if it is late in the evening when camp is reached.

We view with the eye of retrospection this vast work of glaciation, this mighty accumulation of snowflakes, this masterful work of frost and snow and rain. We visualize the majestic moving of the tremendous ice mass as a whole, slowly, surely, unintermittently grinding away the mountain slopes through the ages, carving valleys, making depressions for a most wonderful chain of lakes,—Linderman, Bennet, Tagish, Marsh, Atlin, Surprise, and Teslin, with many smaller



Atlin Harbor offers sanctuary to not a few ships

Sitting in the gloaming by the cheery camp fire after the evening meal,—the silent, sentinel pines dimly lighted, the black wall of night beyond, the vast, unpeopled, primitive wilderness surrounding,—our thoughts revert to the long ago. We think of the Archean world, the Palæozoic Era, with epochs of volcanic activity and mountain building, the Mesozoic Era with its giant reptiles, the Cenozoic Era, with its progress of mammals and extinction of ones,—to be the fountainhead of the mighty Yukon River. With the mind's eye we see the ice mass carrying loam and clay for miles, transporting great blocks of granite and porphyry, leaving these as monuments for man to ponder over and thus to learn to read the mighty works of nature. Wonderful ranges of mountains, cut in the most fantastic shapes of slope, of crest, of minareted peaks, almost unbelievable in their architecture and design, add their beauty

to the picture. Such impressions we are permitted to enjoy free from the hand of nature, if we only take the time and the pains to look,—and, once we look, we experience a deeper understanding of all that is beautiful and divine in the world, without regret for the few golden moments that have been devoted to the unfolding, developing, and ennobling of the soul within.

Up where Auroras flash on high,
And snowy mountains pierce the sky,
And wintry blasts go charging by,
There the Great High North begins.

Up where the huskies pull and strain
At loaded sled o'er snowy plain,
And glorious sunsets glow and flame,
There the Great High North begins.

In the Great High North, 'neath the tundra's glare,
Hidden for æons, the Gold King's lair
Its millions brought forth in the cold gray air,
Where the Great High North begins.

There summer sings a softer rhyme,
In trembling aspen, groves of pine,
And wandering glaciers gleam and shine,
Where the Great High North begins.

There warm the prospectors' camp fire shines,
'Midst balsam boughs and soughing pines;
There the gray wolf howls and the great loon cries,
As the bright moon glows in the eastern skies;
There, far beyond the last tin can,
Are left the haunts of civilized man.

The camp-fire's smoke curls high aloft,
Through which the starshine peeps so soft;
Amidst such scenes, the soul unfolds,
Expanding as the page unrolls;
Brings back to man his truer soul,—
Brings into sight a better goal,
Unfolds the best that in him lies,—
Unfolds a gleam of Paradise;
For here in the presence of the Great Supreme,
The soul a-worship, detects the gleam
Of Mother Nature's love for you,
A love that thrills you through and through;
A love that crushes future sins,
In the land where the Great High North begins.

SCENES FROM THE ATLIN LAKE REGION OF BRITISH COLUMBIA*

FROM HITHERTO UNPUBLISHED PHOTOGRAPHS

BY

L. C. READ

HIGH FALLS ABOVE MORAINE LAKE

[This graceful waterfall, now concealed by a bend in the rock, now emerging to descend precipitously, is one of the many pleasing features of the landscape. Timber line is about 1800 feet above the lake in the foreground

GLACIER BAY

A superb view taken from a vantage point on the bluffs to the south of the bay. It is at Glacier Bay that the traveler disembarks to reach the heart of the region described—a fitting portal through which to enter this land of enchantment

MINTO MOUNTAIN, ATLIN LAKE

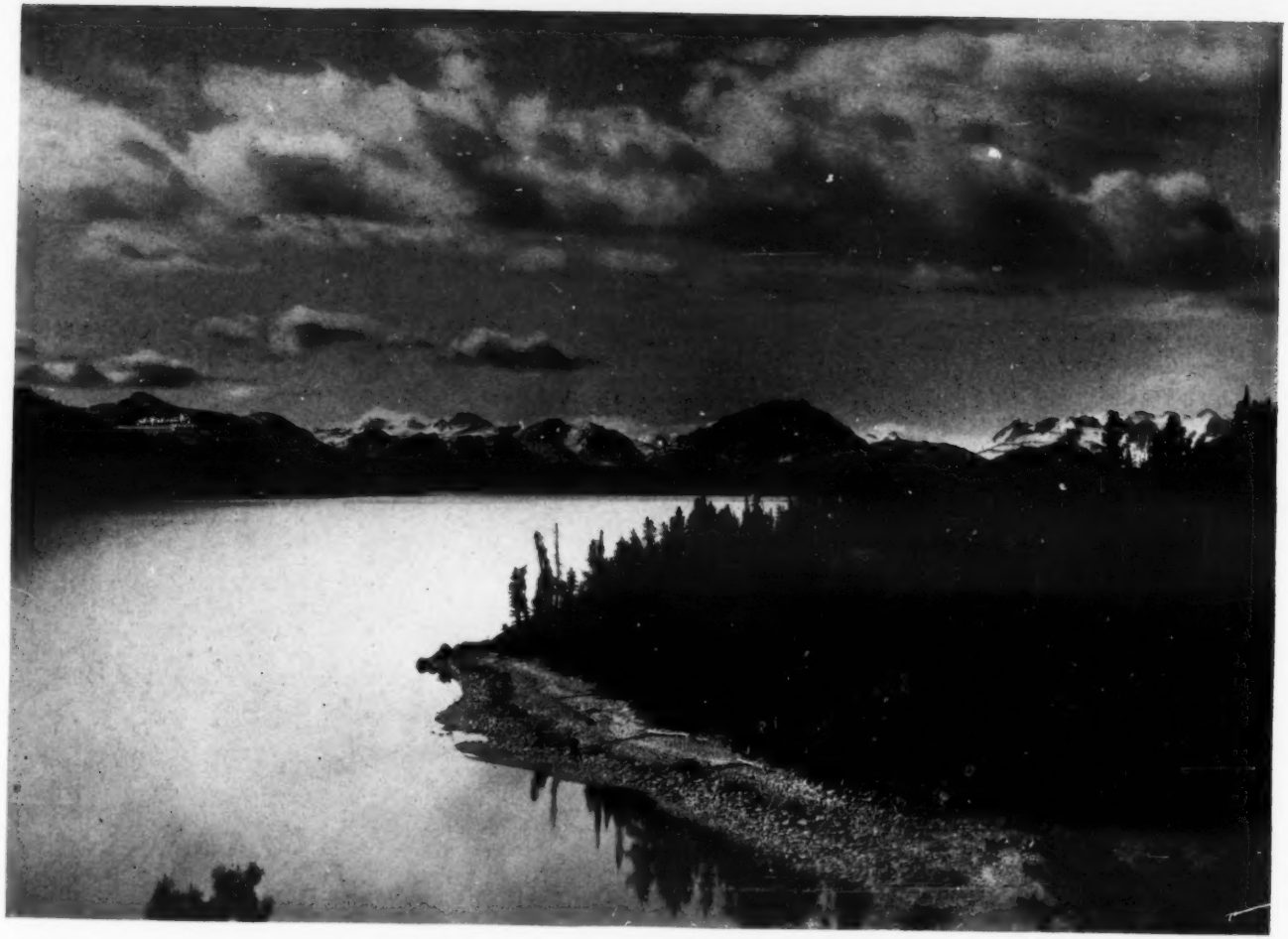
From Third Island one sees in the distance the outstanding mass of Minto, known to the Indian as "Keyun," the birch-tree mountain

LLEWELLYN GLACIER

With its snow and ice stretches aglint, this vast, masterful glacier is one of the glories of the region. The photograph is taken from the east side of Mussen Mountain and shows Llewellyn Mountain, the medial moraine, and the seracs

A VIEW OF THE SERACS

These ice pinnacles, known as seracs, rise to a height of from fifty to one hundred fifty feet. The photograph is taken from a distance of about a quarter of a mile



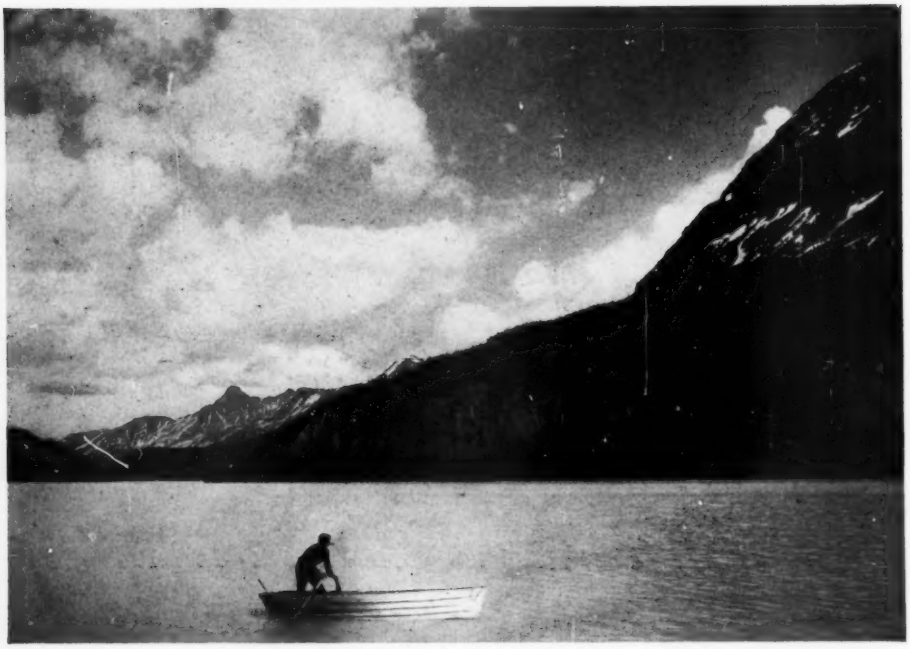
LOOKING OUT FROM DUFF'S ISLAND, IN TORRES INLET

A glorious view is secured from this site of the snow giants that guard the northland. On the extreme left is McCullum Mountain; adjoining it is Sloko Range. The massive mountain in the center is Tsatia, shown also, though from a different angle of approach, on p. 261. On the extreme right, in dazzling raiment, stands Llewellyn Mountain

TSATIA MOUNTAIN

Near the southern end of Atlin Lake, whose waters, ninety miles in expanse, contribute to the mighty flow of the Yukon River, towers Tsatia Mountain, which in the Indian tongue means "the rocky mountain"

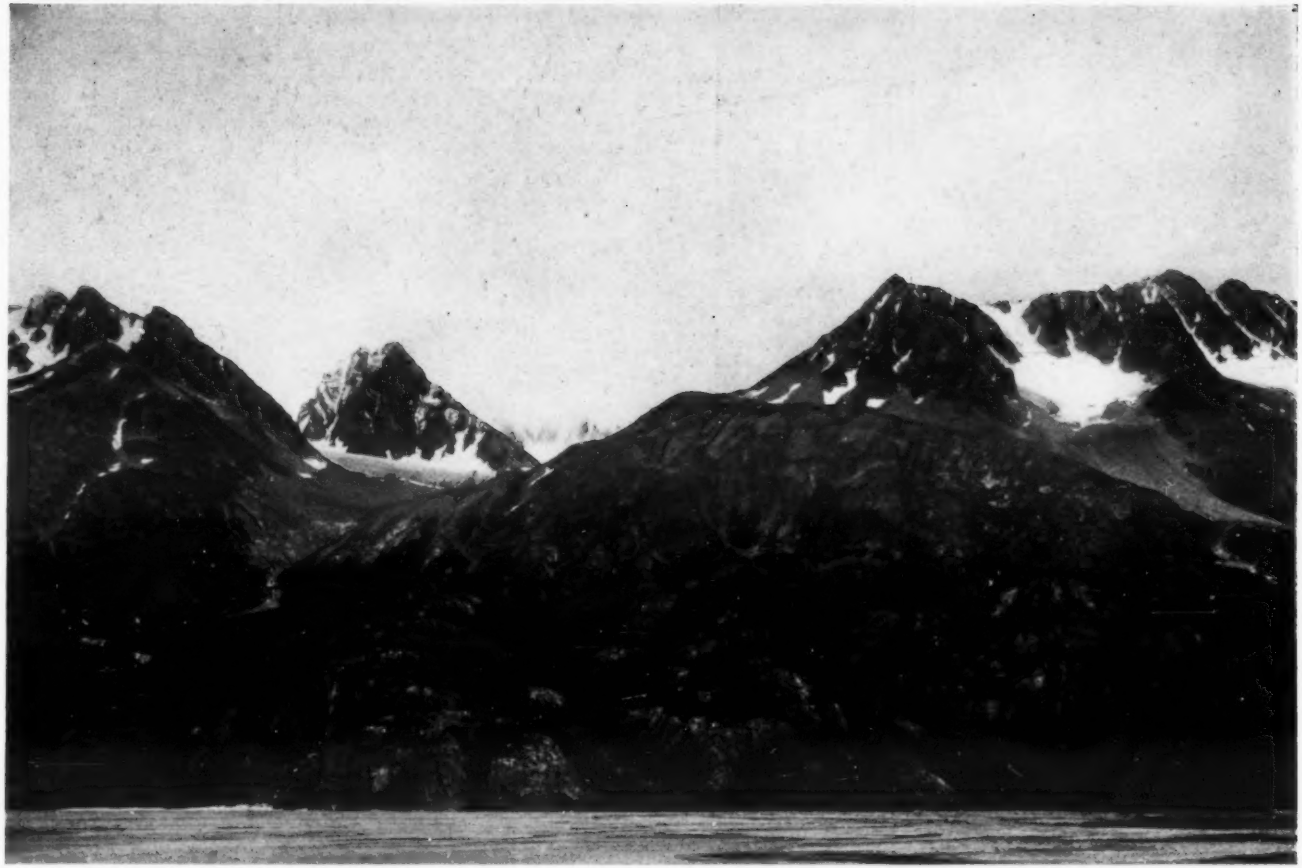
The mountain-girded Glacier Bay, viewed from the bluffs above Moraine Lake. In the middle foreground is the formation known as "the Elevator"



A scene on Sloko Lake. At one time this body of water drained into Atlin Lake, but morainic deposits later blocked its outlet and changed its course

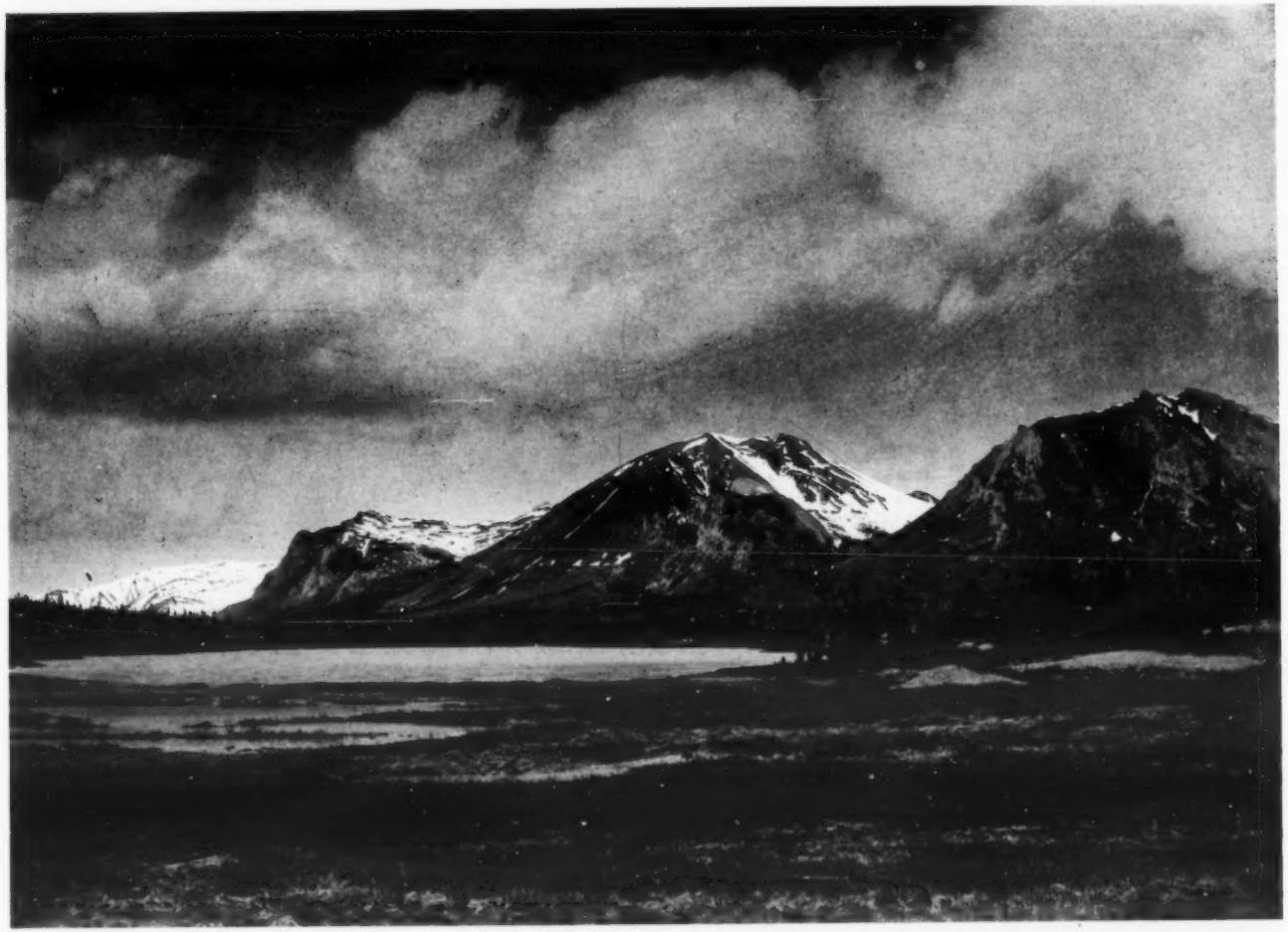
At the northern end of Lake Atlin, Hitchcock Mountain, garbed in snows, confronts the elements. Sentineled by the evergreens, at the right of the picture, is Cole's Cabin

From "the Elevator" one is afforded an impressive view of the titanic mountains at the base of which lies Glacier Bay



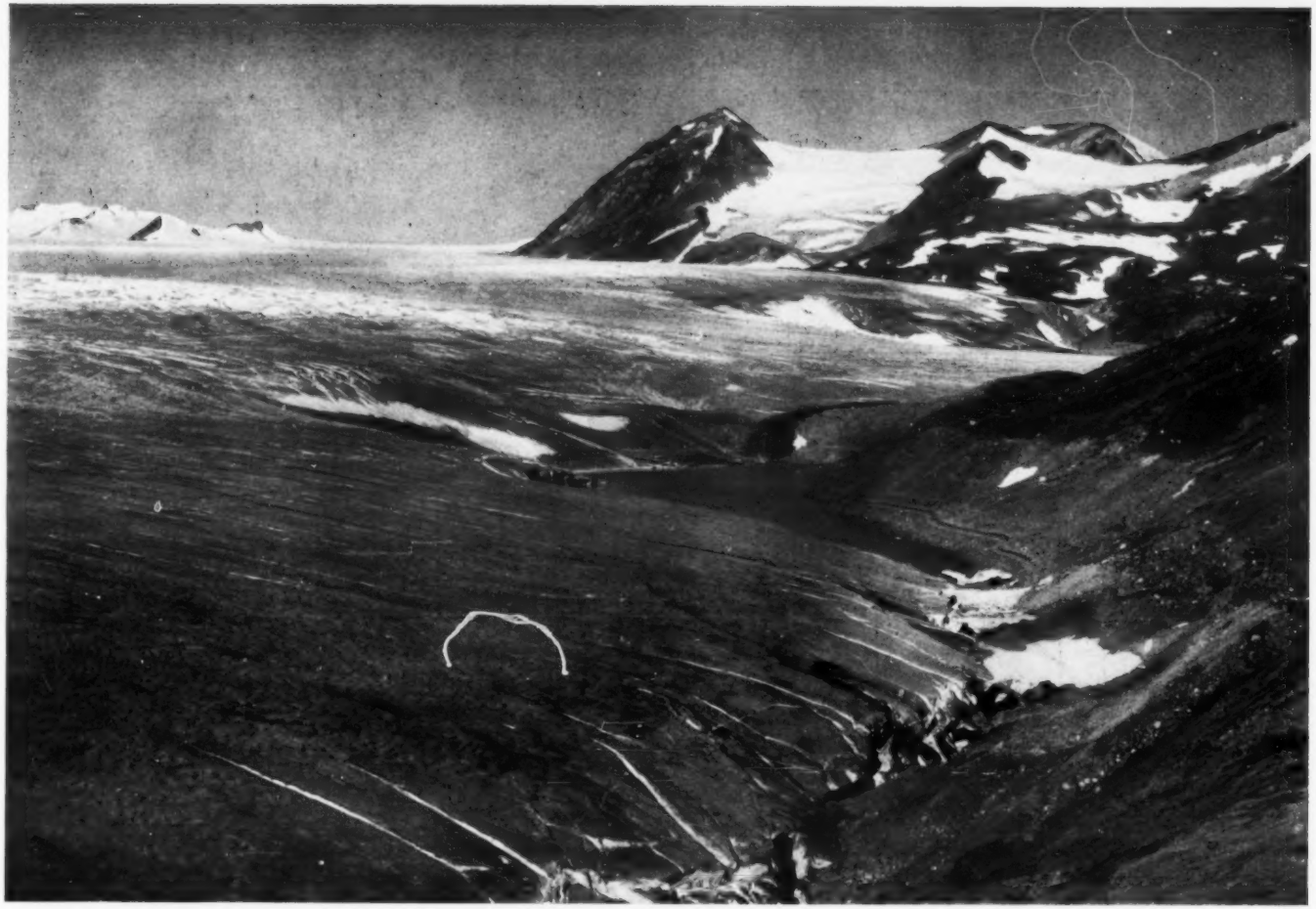
RANGE SOUTH OF THE WEST ARM OF TAKU

This is at the very edge of the great ice field which extends to the south for about seventy-five miles



THE LIMESTONE RANGE

One of the majestically beautiful features of the eastern side of Atlin Lake is this range. The picture was taken from O'Donnell Road



THE DOME OF THE ICE FIELD
The little ice-bound body of water that appears to the right is known as Cerulean Lake

ATLIN MOUNTAIN

The picture shows the work of nivation on the mountain top. This is a telephoto of one of the heights seen in the illustration on page 253

SUMMER EVENING ON ATLIN LAKE

The poet has asked, "What is so rare as a day in June?" Yet rarer is the charm of a June evening in the northern clime with the calm waters of Atlin Lake stretched out before one in majestic repose

RECENT MOVEMENTS OF SWISS AND ALASKAN GLACIERS

BY

CHESTER A. REEDS *

A NEWSPAPER dispatch of May 24 from Berne, Switzerland, states that certain Swiss glaciers are advancing. Earlier accounts state that the snowfall on the Alps Mountains has been very slight during the last winter and, as the rainfall has been very meager during the spring months, the country is suffering from drought. The level of the water in some of the glacial lakes has been lowered to such an extent that "lake dwellings" of primitive man have partly emerged.[1]

Why should the glaciers advance during a season of diminished snowfall? At first thought this may seem incongruous but further reflection will afford an answer. From previous observations it is known that the slight snowfall of this last winter will not affect the lower ends of the Alpine glaciers until 1961, for normally it takes forty years for a season's fall to pass through the length of the larger Swiss glaciers. In other words, the present advance of the ice tongues is due to the heavy snowfall of 1881. These statements are based on the commonly accepted theory of climatic fluctuations of glaciers in the Alps where for a series of years ice fronts advance or recede slightly in response to variation in snowfall. As the sizes of glacier reservoirs vary, some being large and others small, the amount of snow that each will catch will also vary. Another important consideration is the length of the various glaciers. The shorter ones will respond more readily to increased or diminished snow supply than the longer ones. It follows thus that the termini of some glaciers are advancing while others are retreating or stagnant, not yet having responded to the snowfall of a certain season.

The Alaskan glaciers are larger than those in the Alps, in fact they are the largest in the world except those in the polar regions. Most of the glaciers of Alaska are little known; there are thousands of them; a few hundred have received names but many have never been seen; some have been mapped in considerable detail and studied at different times. The various expeditions of the United States Geological Survey, the Boundary Survey, the Harriman Alaska Expedition, and the Alaskan Glacier Studies of the National Geographic Society by Tarr and Martin have contributed scientific reports of great value.

It is held that the mountain districts in Alaska, together with the climatic conditions, are jointly responsible for the existing glaciation. According to Professors Tarr and Martin,—

"It is the combination of lofty mountains facing a sea coast where warm, humid, onshore winds bring abundant moisture, in a northerly latitude, that gives the Pacific mountains of Alaska from 80 to 200 inches of precipitation yearly. It is the loftiness of these mountains, and the northerly latitude, that cause a large proportion of this precipitation to fall in the form of snow. Therefore, much more snow falls in a winter than can melt in a summer, causing permanent snowfields and great glaciers. The variations in altitude, in latitude, in precipitation, and in direction of slope cause the principal variations in the present size and condition of the glaciers. Most of these variations are associated with differences in the mountains, but it is not certain that the climate is responsible for all the glacial oscillations, nor that the ice tongues are consistently waning."

Especially interesting in this connec-

[1] See NATURAL HISTORY, March-April 1921, pp. 172-4

* Associate Curator of Invertebrate Palæontology in the American Museum

tion is the earthquake theory offered by Tarr and Martin for the abnormal glacier advances in the St. Elias Range near Yakutat Bay. In September, 1899, vigorous earth shakings affected the district and huge masses of snow, ice, and rock were consequently avalanched from the mountains to the various glaciers occupying the valleys. Previous to 1899 the history of the glaciers in the Yakutat Bay district had been one of recession and in most of them the retreat continued to 1905 and in some to 1913.

In 1905 it was noted that the Galiano Glacier had undergone great changes, and from the growth of the alder bushes on the moraine it was inferred that the change took place in 1900 or 1901. The Galiano Glacier, whose response was rapid, is a short glacier only 2 to 3 miles long with steep valley sides and head.

The four glaciers, Haenke, Atrevida, Variegated, and Marvine, were completely changed in 1906. These glaciers are somewhat larger than the Galiano, being 7 to 10 miles in length. The first three are about the same size. The Marvine is probably larger. The transformation which took place was from a stagnant condition to activity, and from smooth to broken surface together with actual forward movement and pronounced thickening of the glaciers. In each case the change took place suddenly and terminated abruptly within one year. Since then ablation has been at work healing the broken ice, which has again relapsed into a stage of stagnation.

One glacier, the Hidden, 16 to 17 miles long, probably advanced in the season of 1907. Previous to 1906 its terminus was in a smooth, stagnant condition, but in 1909 its front was two miles farther down its valley. There had been accompanying spreading on the margins and a noticeable thickening of at least eleven hundred feet.

In 1905 and 1906, the Lucia Glacier, 17 to 18 miles long, showed no sign of past change, but in 1909 its moraine-covered lower portion was greatly crevassed and accompanied by lateral spreading.

In 1910 the Nunatak Glacier, 20 miles in length, began to move and before June its tidal front had advanced 700 to 1000 feet with some thickening. There was practically no lateral spreading because the glacier is confined to a narrow fiord.

Some of the larger glaciers like the Seward and the Hubbard have not yet undergone marked transformation. In all probability they will respond when time enough has elapsed for the impulse to pass from their distant reservoirs, through the long valley ice-streams to their fronts.

Thus, by noting the length of each glacier and the time of transformation, the glaciers of the Yakutat Bay district may serve as a rough chronometer of unusual events, such as earthquakes, which may act with or against the more normal movement of glaciers caused by climatic variations.

The earthquakes which affected this district in September, 1899, were the greatest that have been reported in more than one hundred years in Alaska, a region of abundant earthquakes. Elsewhere in Alaska, there have been no changes, so far as can be learned, analogous to those in the Yakutat Bay district. The Alps, whose glaciers have been studied with greater care and for a longer time than those of any other region, is not a section of abundant, great earthquakes.

The reports of the International Committee on Glaciers state that between 1895 and 1907 the majority of advancing glaciers in Europe and Canada moved forward 10 to 60 feet a year. In exceptional cases a few progressed more than 100 feet, and one, the Vernagt-Ferner of the eastern Alps, 450 feet in a year. In response to the earthquake disturbance in Alaska in 1899 the Haenke Glacier in 1906 advanced more than 4000 feet in less than ten months and the

Hidden Glacier more than 10,000 feet in 1907, but these abnormal advances did not last a year. In Europe the glaciers sometimes continue to advance for fifteen or twenty years when once an advance starts, the cycle from maximum to minimum being thirty-five to fifty years.

Last year the Allalin Glacier near Zermatt, Switzerland, advanced 120 feet; it is now moving at an increased rate and has blocked an important pass. Recently, the Lëtschen Glacier has advanced 270 feet; the Schwanenberg 231 feet; the Biserten 345 feet, and the Lower Grindelwald is moving at the rate of 6 inches daily. In fact, it is reported that nearly a hundred important Swiss glaciers under observation are advancing.

The Roseg Glacier of Switzerland, one of the ice-incased glories of the Alps

A TIGER SHARK

The tiger shark is an undiscriminating destroyer of life in the seas, for it does not scruple to bite big pieces out of other sharks in addition to devouring prey of remoter kin. Turtles, crabs, rays, and porpoises, among other creatures, fall victims to its voracity. Even sea-birds alighting on the waves are not immune to its attack. Among the disgorgings of the shark shown in the picture were numerous feathers, the indigestible finery of some plumaged visitant of the ocean

WHAT SHARKS REALLY EAT*

BY

JOHN T. NICHOLS†

FOREWORD: Popularly all sharks are "man eaters." As a matter of fact, very few are guilty of such misbehavior,—not that sharks seem to have any deep-rooted aversion to man as an article of food, although Doctor Coles thinks that they are somewhat particular as to their diet, but it would appear that in many if not most cases where man has fallen a victim to their voracity, it has been because he happened to be handy. What sharks really eat is set down by Mr. Nichols, who has recorded the observations of Doctor Coles and Mr. Bell.

The illustrations accompanying this article are from photographs kindly supplied by Dr. E. W. Gudger. The hammerhead depicted was harpooned in the harbor of Beaufort, N. C.; the tiger and the nurse sharks were taken at Tortugas, Fla., at the Marine Laboratory of the Carnegie Institution of Washington.—F. A. LUCAS.

SEAS all over the world have their sharks, as they doubtless have had since far back in geologic time, but these marauders are not nearly so numerous in high latitudes or temperate regions as along the sun-baked shores of the tropics. As we go south along our own eastern seaboard, they become abundant at the capes of the Carolinas, where the Gulf Stream hugs the shore for the last time before spreading out to the east across the Atlantic, and here, at Morehead City, North Carolina, near Cape Lookout, Mr. J. C. Bell, of the American Museum's department of preparation, spent some weeks last summer obtaining plaster molds for reproducing sharks for our exhibition series. He was the guest of the Ocean Leather Company, which furnished specimens for and aid in casting. Dr. Russell J. Coles, who was instrumental in arranging for Mr. Bell's trip and who was himself "sharking" off Cape Lookout, also provided specimens. It was Doctor Coles, it may be remembered, who secured the great devil fish or *Manta* which hangs above the fish exhibit in the north corridor of the American Museum. Some excellent material was obtained which will, in due course, be placed on exhibition. More than that, thanks to Mr. Bell, exceedingly interesting observations bearing on the habits of sharks were made.

The tiger shark (*Galeocerdo tigrinus*) is a large species found in all warm seas, and whether considered from the point of looks or habits, the name is most appropriate. It has a blunt head and heavy shoulders. The body tapers back to a long, slender tail, and its sides are marked with dark stripes and spots. This marking is quite distinct in the young, but as the shark grows it becomes less well defined, like a pattern in watered silk, and, it is said, finally disappears altogether. The tiger shark's maximum length is thirty feet, but specimens of the largest size are seldom seen. Its mouth is very large, and is armed with a row of big, flat, cutting teeth quite different in outline from those of any other shark. Each tooth is roughly sickle-shaped with a fluted edge suggesting a patent bread knife and a triangular point at the summit projecting obliquely outward.

This is one of the sharks most dreaded in the West Indies, and, indeed, it seems quite capable of living up to the evil reputation of being a man-eater, although we know of no authentic evidence that it is such. Dr. Coles has written of it in the following words:[1]

"There can be little doubt that the tiger shark regularly preys on other sharks to a considerable extent. During the few weeks that I was watching the fishery at Cape Lookout I examined the stomachs of three young tiger sharks, and in all three I found cleanly bitten pieces of freshly eaten shark meat with skin attached, just as if the chunk of meat had been cut from the side of a

[1] Coles, Russell J., "The Large Sharks of Cape Lookout," *Copeia*, No. 69. 1919.

† Associate Curator of Recent Fishes, American Museum.

The tiger shark has the evil reputation of being a man-eater. Even if its alleged propensity as such be exaggerated, its capacious jaws would have no difficulty in encircling a human victim, a small boy being a particularly manageable morsel

shark. In the largest example, 7 ft. 9 in., in length, caught in my nets June 25, there were eleven of these chunks of shark meat of from one to five pounds each in weight, and they represented *hammerhead*, *sharp-nosed*, and *ground sharks*.

"Additional observations made during the first week of August on three more tiger sharks, each in excess of twelve feet in length, confirm my former observations as to the varied character of their food. In one of them I found a freshly eaten loggerhead turtle, approximating 100 lbs. in weight, which had been bitten through both shells, in three places and the pieces of shell much crushed, yet all parts of the turtle were present.

"Probably tiger sharks will use as food, when hungry, any creature which they find moving in the water, for which reason they must be dangerous as man-eaters; but I do not regard them as nearly so dangerous as a white shark which has once acquired the habit of eating human flesh. While it is not fastidious, I have no evidence as yet that even the tiger shark will eat unclean food, and in my opinion, the sharks which eat garbage or putrid matter are exceptional individuals, which, through some accident, have acquired the habit."

Speaking of a 12½ foot individual, he says: "Stomach contained most varied assortment of food that I have ever found in any shark, consisting of parts of three very large stone crabs, one bird, the small diver called locally water witch, and various unidentified substances."

Mr. Bell examined the stomach contents of more than thirty individual tiger sharks, mostly from nine to twelve feet in length. Of these sharks 76 per cent had been eating such large creatures as sea turtles, other sharks, and large rays and porpoises; 38 per cent had consumed a variety of smaller creatures (crabs, horseshoe crabs, mackerel, shad, and other fish, and in one case a water bird); 6 per cent had swallowed the bones of domestic animals, probably in their rôle of scavenger. That is, it was found that one individual contained among other material beef bones and hair, and a second, landed on the dock still alive, vomited several small mammal bones, among which the leg bones of three sheep have been identified.

Other sharks constituted the largest single item of diet for the tiger sharks examined. The stomach of an individual 11 ft. 3 in. long contained a large piece from the side of the head and gills of an eleven foot hammerhead taken in the net with it. In the stomachs of four tiger sharks taken on July 13

were found black-tip sharks (*Carcharhinus limbatus*) bitten in large pieces, some about in half. An individual 12 ft. 2 in. long had swallowed a large shark of 8 or 9 ft. bitten into seven or eight pieces. An eleven foot individual contained a small hammerhead of about $3\frac{1}{2}$ ft. intact and several parts of other sharks. In most cases, at least, the sharks consumed appear to have been caught in the nets and so to have fallen an easy prey. It is doubtful if so many of them could have been captured in the open, although the evil tiger doubtless carries always with it the will to consume its weaker brethren.

It is more than doubtful if the tiger shark is ever quick enough to capture porpoises in the open, but it must be a very serious enemy to the rather sluggish loggerhead turtles, through the tough shells of which it bites with comparative ease. Several of those which Mr. Bell examined had pieces of big turtle in their "innards," and one large female contained a loggerhead intact. Mr. Bell's observations attest to the ravenous appetite of this shark and the variety of its food. In this particular case, owing to the fact that other sharks were being taken in the nets in large numbers, these made up much of its diet. Ordinarily loggerhead turtles and valuable food fish are probably consumed in quantity.

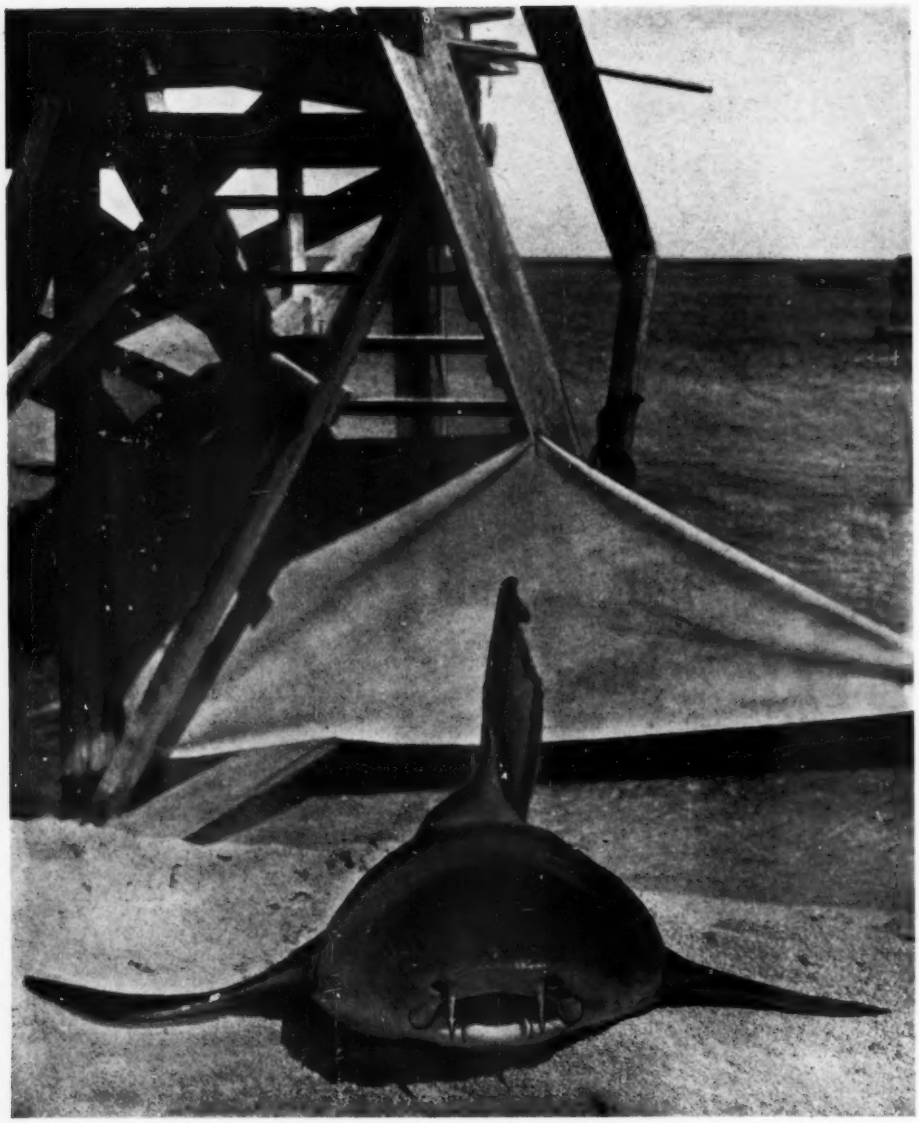
From the stomach of one of these sharks was taken the tail spine—more than a foot long—of a big horseshoe crab; why a shark should eat creatures about as nutritious as a basket of shavings is a puzzle—a still greater puzzle is why the long and sharp spine did not pierce the walls of the stomach.

A comparatively small series of large cub sharks (*Carcharhinus commersonii*) were examined. Making allowance for their somewhat smaller size, these showed a very similar range of food to that of the tigers—including smaller sharks, rays, the fin of a porpoise, shad, mackerel, and crabs.

Among the formidable and voracious denizens of tropical and subtropical seas is the hammerhead shark. The eyes of the shark are located at the extremities of the mallet-like prolongations. The object of this peculiar head structure is apparently to function as a bow rudder

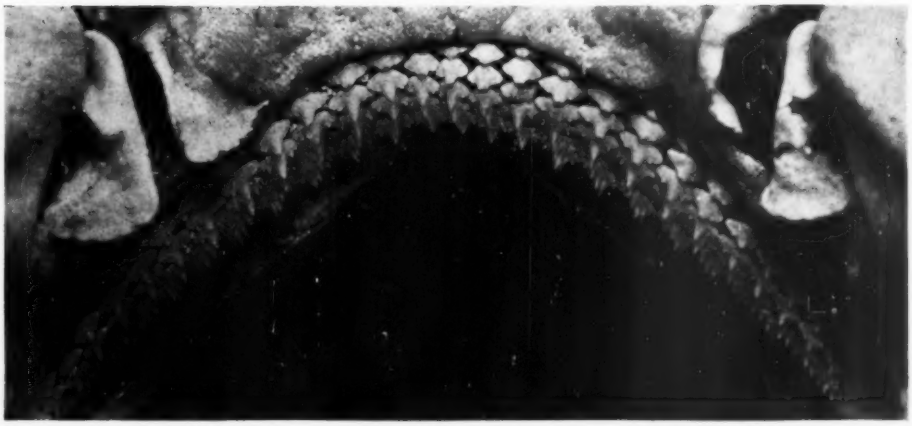
Thus it appears that while sharks have an evil reputation, they are far more dangerous to one another than they are to man, and while from man's point of view cannibalism is not considered good form, yet among sharks it may be tolerated as tending to lessen their numbers. And now that man has begun utilizing sharks for food, leather and fertilizer, our sympathies are largely with the sharks.

The nurse shark (*Ginglymostoma cirratum*) is a creature of different make-up from the species we have been discussing. It is a rather slow-moving animal with a



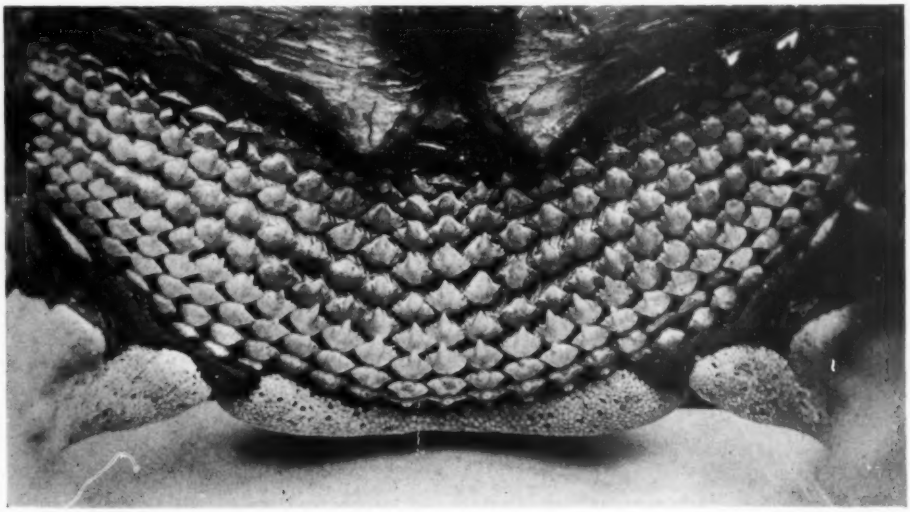
A HEAD-ON VIEW OF A NURSE SHARK

More slow-moving than many other species, this shark must nevertheless be the equivalent of a "do not trespass" sign to many of the smaller swimmers. Its eight or nine feet of length and three hundred to four hundred pounds of weight require many a squid or inkfish for proper maintenance



small, thick-lipped mouth. Its teeth also are small, although each one is sharply pointed, and they are arranged in a sort of pavement, with their points directed backward, all or most of the rows functioning at the same time. In the tiger shark or in the numerically abundant ground shark group to which the cub belongs, only a single anterior row of big, cutting teeth is erect and functional, numerous other rows lying superimposed out of the way behind it, in turn to become erect and functional as the preceding row is worn out and discarded. The nurse shark has an exceedingly tough, resistant hide, so heavily armed with minute bony points as to be difficult of penetration by a harpoon. This hide may furnish some protection against its fierce relatives, at any rate, they do not appear to prey on it, although it is too sluggish to get out of their way. Two nurse sharks between eight and nine feet in length, each weighing between three and four hundred pounds, had been feeding on squid or inkfish, and one of them also contained a little, partly digested shrimp.

One of these nurse sharks was a female, containing twenty-eight eggs,

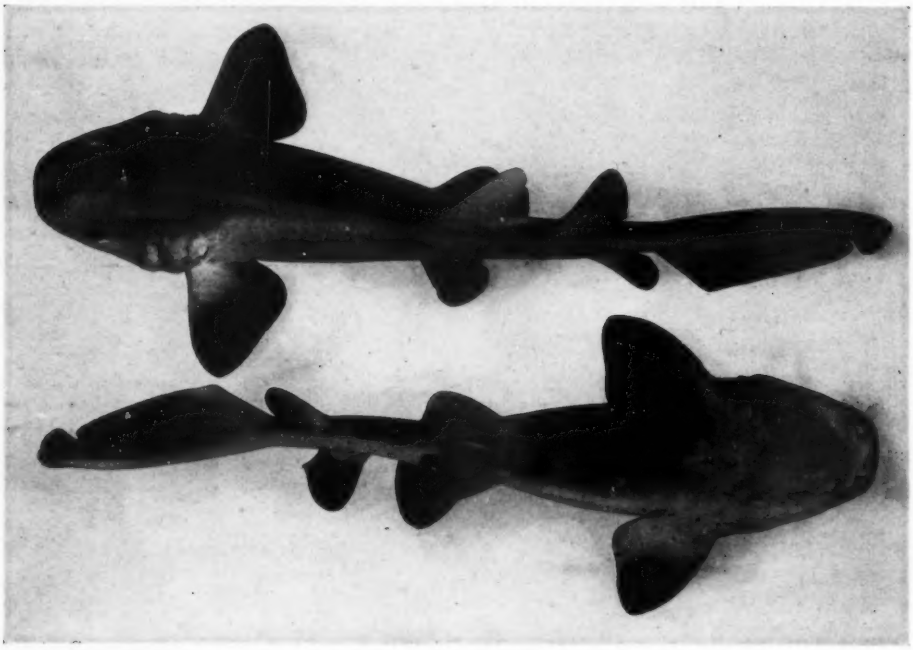


Equipped with row upon row of sharply pointed teeth, all or most of which function at the same time, the expanded jaws of the nurse shark spell peril for any small creature that is luckless enough to attract the hungry gaze of this shark

each about as large as a goose's egg and with a delicate, horny shell. They suggested the tougher-shelled eggs of skates, which are washed up along our shores in great abundance and are called "sharks' eggs" or "devil's pocketbooks" by seaside visitors. Above these there were a large number of smaller eggs ranging from the size of a pea to that of a large-sized marble.

Present-day sharks differ little from those which swam the seas in early geologic time, the first and simplest form of true fishes, and yet it is among the sharks and rays (which are no more than flattened sharks) that we find the most highly developed systems of reproduction in the fish world. In most modern sharks the young attain considerable size within the body of the mother, and the egg and helpless stages, in passing through which other young fishes must face so many dangers in the ocean, are thus protected. This is true of all our eastern, coast-wise species, with the possible exception of the nurse shark. In other parts of the world there are sharks which lay large eggs with tough shells like skates' eggs.

Dr. E. W. Gudger has for years been especially interested in the case of the nurse shark. He believes that the egg of that species, although it has a shell, is never deposited and that its young also are born alive. If this can be proved, we have in *Ginglymostoma* an extremely interesting transition form, for an egg-shell would not be formed unless this genus or its immediate ancestors deposited their eggs.



These are young nurse sharks. The lower of the two fish is placed on its back in order to show the conformation and markings of the under surface. In a still earlier stage numerous spots are found also on the upper surface

FISH AS MOSQUITO DESTROYERS[1]

AN ACCOUNT OF THE PART THEY PLAYED IN THE CONTROL OF YELLOW FEVER AT GUAYAQUIL, ECUADOR

BY

MICHAEL EDWARD CONNOR, M. D.

GUAYAQUIL, Ecuador, one of the oldest cities of the Western Hemisphere, has at no time been noted for the salubrity of its climate. Don Antonio de Ulloa, who visited it toward the middle of the eighteenth century, reported that even then fevers were very common there and, knowing as we do to-day that certain insects are responsible for the transmission of certain diseases, his further comment has especial interest. "Though all these hot and moist countries swarm with an infinite variety of volatile insects," writes the Spaniard, "yet the inhabitants are nowhere so greatly incommoded as at Guayaquil." Writing as recently as 1912 the Right Hon. James Bryce refers to Guayaquil as the pesthouse of South America, the last stronghold on the continent (if one excepts the banks of the Amazon) of the deadly yellow fever.

Today, less than a decade after the denunciation just cited was written, Guayaquil is a city redeemed from the yellow fever peril, which, first recorded in that community in 1740, maintained its hold until May, 1919, when the last case was officially reported. All Ecuador, and not merely Guayaquil, is enabled to take a forward stride as the result of this accomplishment, for the isolation imposed upon the chief port of the country has been an important factor in retarding the development of the wonderful resources of the republic.

How was this improvement in sanitation brought about? The reader familiar with the achievements of our government in controlling disease-carrying mosquitoes at Panama and elsewhere will not unnaturally assume that fumigation, oiling, screening, and the inspection of mosquito-producing containers were the methods resorted to. In Guayaquil, however, partial reliance was placed upon an animal ally of man—a fish so indefatigable in the destruction of the larvæ of the dangerous *Stegomyia* mosquito that through its agency the breeding of this insect in small containers has been reduced from 100 per cent. to less than 2 per cent., a figure not far from complete extermination.

The yellow fever mosquito breeds by preference in fresh-water containers in or near human habitations, and is rarely ever found in pools of water on the surface of the ground and never in the fields or swamps. It is a domestic mosquito and clings to inhabited buildings with tenacity. It does not fly any considerable distance and avoids direct sunlight. The female deposits between one hundred and one hundred fifty eggs at a time. These eggs are deposited on the surface of the water, always in a barrel, tank, tin can, flower vase, broken bottle, or some other receptacle holding fresh water. From each egg there comes a wriggler or larva, which after several molts finally reaches the adult stage and, if it be a female, starts at once to secure a victim from whom to suck blood. Should this victim be ill with yellow fever in the early stages, the mosquito will take up in the blood germs of the disease, which after a period of about twelve days in its body will be injected into the next victim that the mosquito bites.

The water supply of Guayaquil pro-

[1]At about the time that Dr. Connor was engaged in yellow fever control, the Rockefeller Foundation, under whose auspices his work was conducted, also became interested in the rôle played by fish in malaria control. The latter demonstration was conducted by Dr. H. H. Howard (Director for the West Indies of the International Health Board) in Hinds County, Mississippi, from 1918 to 1920. A report of this work is found in Document No. 7486 of the International Health Board, entitled, *Use of Top Minnow (Gambusia Affinis) as an Agent in Mosquito Control.*—THE EDITOR

vides for only forty liters per capita per diem, and this quantity of water is delivered to the people during two hours each day. It is, therefore, absolutely necessary to store water in some sort of container if the household expects to have sufficient to meet its daily needs. The containers used in Guayaquil can be divided into two classes—tanks and other receptacles. Tanks are to be found in the better equipped homes and are permanent fixtures. They have a capacity of from one hundred to five hundred gallons and are provided with valves for the intaking and outletting of water. They are located against a wall or partition, high up to gain head pressure. There are more than 7000 tanks in service at Guayaquil. Other receptacles comprise barrels, oil tins, large earthenware bowls, etc.; the last census made by sanitary inspectors showed more than 30,000 "other receptacles" in actual use.

The problem at Guayaquil was how to conserve the water for a population of 100,000 and at the same time render the containers mosquito-proof, and to accomplish this within as short a time as possible because speed meant a great saving in human lives. The first thought would be to destroy the mosquito breeding places, by doing away with containers. This could be achieved by installing a modern water system carrying an abundance of water which would be available to the people at any hour of the day or night, but this work could not be consummated under two years from the date of its inception and in the meanwhile yellow fever would be killing hundreds. The government of Ecuador has contracted for a modern system of potable water, and the work is being rushed to completion. The problem of controlling yellow fever while awaiting the installation of the water system reduced itself to mosquito-proofing all necessary water containers in the city.

The device used in Cuba and Panama, namely, covering the mouth of the barrel with wire screening and placing a spigot in the lower part from which water might be drawn, was a practical measure in ordinary times and was used in Guayaquil for a short time. But because of the difficulty of securing materials in Ecuador, it was thought best to try the method of straining the water through muslin to separate the mosquito larvæ. This required, however, a great deal of time, and there was always the possibility of contaminating the water through a typhoid carrier in the sanitary squad.

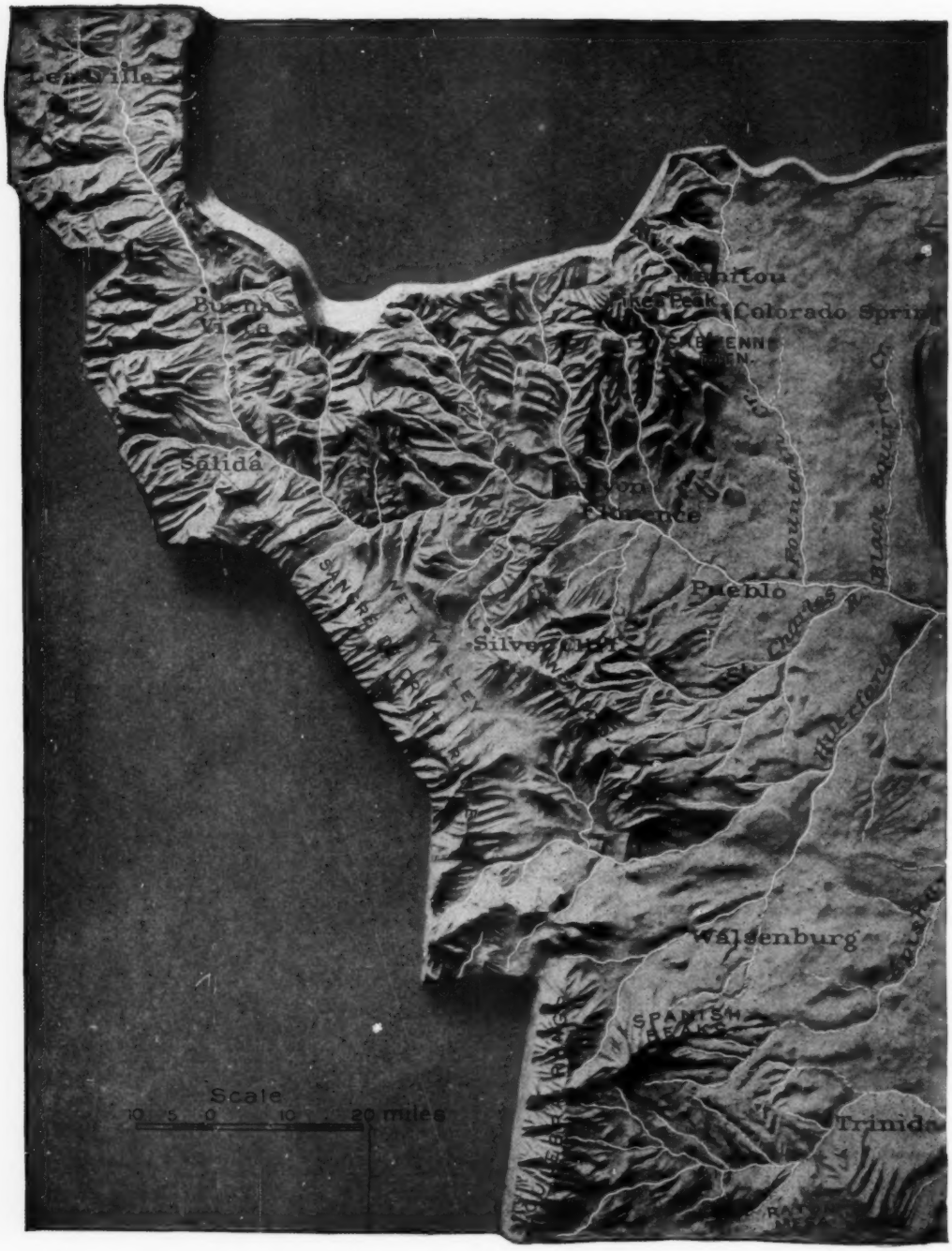
A small fish, commonly known as the top minnow, had been introduced into Ecuador some years before the present campaign started. This fish is found in streams and will consume mosquito larvæ. We experimented with top minnows in fresh water containers but found them unsatisfactory for ordinary receptacles, such as barrels, etc. They would not eat the mosquito larvæ in these containers if other food material was available, and as the water in Guayaquil is delivered to the people untreated, it has with it considerable débris. On this sediment the top minnows lived contentedly. In a glass jar in the laboratory they would readily eat all mosquito larvæ given them, but when placed in a barrel or container, they were less dependent on this food. Again, the top minnow is not a hardy fish, and the concussion produced by dipping a pail into the water barrel was sufficient shock to kill it. The hope nevertheless persisted that a fish with capacity for consuming mosquito larvæ and yet possessing sufficient hardiness to resist rough treatment might be found in the streams near Guayaquil.

The next fish experimented with is known locally as the *huijas*, a variety of perch. This fish is a voracious eater of mosquito larvæ and resists well the rough handling of long trips in pails and cans. With this fish our problem appeared to be solved, but after a few weeks' trial the *huijas* revealed itself as extremely restless and as unwilling to ac-

commodate itself to the small containers. It also exhibited remarkable jumping qualities, rising sometimes three or four feet to free itself from the container. The *huijas* was abandoned for the *chata*, a sardine. This fish possessed all the good qualities of the *huijas* and none of its defects. It had the additional characteristic of spending the greater part of its time on the surface of the water, but when anyone approached the container, it would swim to the bottom and remain there until the cause of its fright was removed. The *chatas* are not plentiful and are, therefore, more expensive to use than the *chalaco*, the next fish tried, which was finally adopted as the most satisfactory for consuming mosquito larvæ and mosquito eggs in small containers. The net cost per fish to the Yellow Fever Service is one-half cent, and this will be reduced as soon as the hatcheries already established come to production.

The method of using the fish for the purpose of mosquito-proofing water containers is simple in the extreme. Contracts are made with local fishermen to deliver so many thousand *chalacos* in good condition at our *bodegas*, where they are placed in a specially prepared well, the conditions of which approximate those of the stream from which the fish have been taken. After a few days the fish are removed to a second well, the water of which is the same as that used by the city. No food, other than that which the fish find in the water, is given them. Sanitary inspectors notify the *bodegas* a day previous to the distribution as to the approximate number of fish they will require for their districts that day. The fish are then taken from the wells and placed in tins or pails and delivered to the inspectors. Instructions have been given to each inspector that every fresh-water container in his district is to be supplied with one fish, regardless of the presence or absence of mosquito larvæ in the container at that time. The public is encouraged, personally, by notices in the newspaper, and by the inspectors themselves, to exercise reasonable care in protecting the fish. The public of Guayaquil has responded in a whole-hearted manner to the requests of the Yellow Fever Service, and many families have in their possession at this time the identical fish which was given them to mosquito-proof their water container nearly eighteen months ago.

More than 30,000 water receptacles have in this way been purged of mosquito larvæ in a relatively short time and at a minimum of expense. With the continued use of fish it is believed that the yellow fever mosquito can be reduced to such small numbers that, should a few cases of the disease be introduced into the community, it would not spread.



DRAINAGE BASIN OF THE ARKANSAS RIVER IN COLORADO

Pueblo and the region about it suffered most through the recent devastating floods, which left in their train death and destitution and spread terror even to regions beyond the reach of their menace

FLOODS IN THE PUEBLO DISTRICT

BY

CHESTER A. REEDS*

THE recent disastrous floods at Pueblo and other Colorado towns in the Arkansas River valley have attracted nation-wide attention. The floods on the Platte River at Denver, Colorado, although less severe, have also damaged property and caused loss of life. These river floods have arisen from torrential rains and cloud-bursts in the headwaters of the Arkansas and Platte rivers. According to the reports of the United States Weather Bureau, the amount of precipitation in inches at Pueblo and Denver was as follows:

	Pueblo	*Denver*
June 2, 1921	.12 inches	.02 inches
" 3, 1921	1.80 "	.08 "
" 4, 1921	2.92 "	2.04 "
" 6, 1921	.08 "	.06 "
Total	4.92 "	2.20 "

The newspaper accounts state that rain fell in this district on June 5 but the Weather Bureau reports the Pueblo record for that date missing; Denver, .42 inches. The annual precipitation for Pueblo and Denver is slightly under 15 inches. It is thus remarkable and unusual for one third of the annual precipitation to fall at Pueblo in the four days mentioned above. On May 31, 1894, Pueblo was swept by a flood similar to that of June 4, 1921.

The question thus naturally arises what peculiar geographical position has Pueblo that the city is subject to sporadic floods of such violent character as those reported in the daily press for the first week of June?

Pueblo and Denver are cities on the western margin of the Great Plains. These plains form a high plateau about 5000 feet above sea level and extend in a north-south direction from the Mexican border well into Canada. They are several hundred miles in width and slope gently to the east. Bordering the Great Plains on the west is the Rocky Mountain tract, which rises abruptly to an average elevation of 10,000 feet. Some of the mountain peaks rise higher, to 12,000 and 14,000 feet above sea level. Pueblo is situated at the confluence of Fountain Creek and the Arkansas River about ten miles east of the main Rocky Mountain front. Just west of Pueblo, however, the Great Plains embay the Rocky Mountain tract for an additional twenty miles so that a huge crescent-shaped amphitheater with a radius of about thirty miles centering at Pueblo lies to the west of the city. It was in this huge receptacle that the greater portion of the 4.92 inches of rain fell during the first week of June and converged upon the city.

Fountain Creek, which enters the valley of the Arkansas River at Pueblo through a narrow defile from the north, is primarily a Great Plains stream about sixty miles long. It drains the Rocky Mountain front about Pikes Peak, Colorado Springs, Manitou, and about twenty miles to the north of those places. Following heavy rains in the mountains at and above Pikes Peak, it becomes a raging torrent throughout its entire course. Most of the water which flooded Pueblo in 1894 came down this stream.

The Arkansas River, which enters Pueblo from the west across the floor and through the mid-portal of the Pueblo amphitheater, rises in the high Rocky Mountain tract about Leadville, Colorado, some 150 miles to the northwest of Pueblo. Many lateral tributaries are received by the river on its way to the Great Plains. The area drained is more than 4000 square miles in extent and is rudely triangular in shape with a 75-mile front facing Pueblo. The

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normal rainfall in the mountains is 20 inches while that on the Great Plains is less than 15 inches annually. During the three months of January, February, and March, the precipitation west of Pikes Peak averages 5.1 inches as contrasted with 1.4 inches at Pueblo. The normal annual snowfall in the mountains and on the plains about Pueblo and Denver is 40 inches, normal sunshine 60 per cent., normal temperature 50°, maximum 85°, minimum 15°. Had the precipitation during the first week in June been as heavy in the mountainous sections drained by the Arkansas River as in the Pueblo amphitheatre, the floods would have been far more disastrous than they were. Normally there is a large volume of water in the river passing Pueblo.

Pueblo, a city of 42,908 inhabitants according to the 1920 census, is situated in the valley of the Arkansas River at an elevation of 4675 to 4750 feet above sea level. The normal flood plain of the river, which has been narrowed during the growth of the city, was originally about one half mile wide and divides the city into north and south sections. Except for a narrow strip along the river bank the south section is built on an old alluvial terrace more than fifty feet above the river. Most of the north section is lower, with an average elevation of 4700 feet above sea level. A narrow insular remnant of the old alluvial terrace, which parallels the west bank of Fountain Creek at the confluence forms a bit of higher ground. The northern limits of the city extend into the uplands facing the river some two miles distant. Fountain Creek divides this section into two parts, with the main portion west of this stream and the Grove section to the east.

The transporting power of a large river in flood time is most surprising. It varies as the sixth power of the velocity. Thus if the velocity of running water is doubled, it increases its transporting power sixty-four fold. Swift streams, therefore, have enormously greater power of transportation than sluggish ones. The Arkansas at Pueblo in normal times has considerable water and a strong current, for bridges are necessary, but during flood its velocity and consequently its power may be increased enormously. The chief elements upon which the velocity of a stream depends are its gradient, its volume, and its load of sediment. The steeper the gradient, the greater the volume, and the less the load, the greater the velocity. The average grade of the Arkansas River from Canyon City at the mouth of the Royal Gorge across the floor of the amphitheater to Pueblo is 15 feet to the mile, from Pueblo to La Junta, 8 feet, and from La Junta to the Kansas line, 7.3 feet. The area of the Pueblo amphitheater, with a radius of thirty miles, is 1413 square miles. The recorded rainfall over this surface for the first week in June was 4.92 inches and with one day's record missing, the total may have been 6 inches. Imagine half a foot of water 1413 square miles in area on a grade of not less than 15 feet to the mile, augmented with a very large but unknown amount arising from a mountainous tract more than 4000 square miles in area, pouring through the small end of a huge funnel at Pueblo. It is true a portion of this rainfall may have sunk into the ground and a part evaporated, but it is assumed that far more than one third of it ran off, for it fell, for the most part, on impervious shale rock and during a few days.

It is not surprising, therefore, that whole trains standing in the railroad yards were dashed from their tracks and that bridges were carried away by the onrushing wall of water, which rose up to the level of second-story windows and continued for days. The load of sand, gravel, and mud, besides wreckage of every description, must have been enormous.

Where mountain streams debouch upon a plain, they drop a considerable por-

tion of their load, particularly the large boulders and pebbles. This is due primarily to an abrupt change in gradient, which affects the velocity and consequently the transporting power of the stream. Where the declivities are steep and the streams short, alluvial deposits arise with cone-shaped outline, the base resting on the plain and the top leaning against the mountain. In the next step where youthful river courses are defined the sediments are spread fanwise over the plain at the foot of the mountains. In a later stage of development where the various streams have had time enough to work headward far back into the mountains, to cut deep cañons and to unite, forming the head waters of a large river such as the Arkansas, the change in stream gradient from mountains to plains is not so abrupt as in the earlier stages and fine deposits are strewn for hundreds of miles along the river course.

The present Arkansas River and its tributaries flow in deep and narrow cañons in the mountains, but in crossing the Great Plains their valleys are wide and average about two hundred feet below the surrounding higher lands. Between Pueblo and the mountains the Arkansas valley is bordered in places by cliffs of moderate height. but to the east the side slopes are very gentle.

Extensive deposits of conglomerates, sand, sandstone, gravel, and clay, known as the Monument Creek formation, appear on the high divide between the Platte and Arkansas drainage basins from the foot of the Rocky Mountains eastward. There are two members, a lower one of sand and clays and an upper one of conglomerate and sandstone. They cap numerous buttes and plateaus. These sediments represent fan-shaped deposits of the early Tertiary. Fossil bones of *Titanotherium*, found in the upper member, indicate Oligocene age.

Deposits of loose sand and coarse gravel about two hundred feet thick cover wide areas of the high plains adjoining the Arkansas valley in eastern Colorado and extend westward to the vicinity of Fountain Creek. They have been named the Nussbaum formation and are supposed to be of Pliocene age. Locally the beds consist of loose sandstones or very sandy limestones with carbonate of lime acting as a cement. These beds are of alluvial origin, having been spread where they lie by the flowing water of streams.

Along the Arkansas River below Pueblo appear large areas of alluvium. The thickness of this deposit is from fifty to sixty feet in the central portion of the valley and has a width in the bottom lands from three fourths of a mile to a mile. It consists of fine sands and loam laid down by the river at various stages. During floods coarser material is added, particularly on the lower flats. Similar alluvial deposits constitute the bottom lands along Fountain Creek. Higher terrace levels appear in places along these streams, capped by sand and gravel. The higher deposits represent early, and the lower ones, the present or late Quaternary deposition.

Thus it may be stated in conclusion that, whereas great floods have occurred sporadically at Pueblo since the founding of the city and oftentimes during late geologic periods, they are bound to occur again. The causes are natural and cannot be changed. If the river's course is kept free from unnecessary obstructions and as wide as possible, the danger is not apt to be so great. With city parks along the river banks and strong levees behind them the remainder of the city occupying the low ground may be kept free from floods.

THE GOLDEN AGE OF PERU

BY

HAMILTON BELL

This article serves as an introduction to the high period of Peruvian culture, which terminated suddenly with the Spanish conquest. In a subsequent issue of NATURAL HISTORY Dr. P. E. Goddard will give an account of the gold utensils and precious ornaments of the period antedating the conquest that have come into the possession of the American Museum. The acquisition of the splendid Peruvian collection, including in addition to the objects of gold, interesting textiles, characteristic pottery, and other mementos of the ancient culture, is due, in the first place, to various benefactors, beginning with Henry Villard in 1892 and including the late Frederic A. Juilliard, and in the second place, to the explorer and scholar, Adolph F. Bandelier.

GOLD, in the Ancient World, has from the earliest times held the first place in the scale of values. The Golden Age was to the Greek the *sumum bonum* of existence. The Christian can imagine no bourne more desirable than the Heavenly City—Jerusalem the Golden. The earliest heroic adventure was the quest of the Golden Fleece. The highest praise that could be given to anything was to call it golden. When currency became a necessity, it was first coined, in Lydia, of gold, which thus became the standard for the world. In the civilization of the Mediterranean gold became the symbol of all wealth and the object of general greed.

Gold was known to the natives of Peru long before the Spanish conquest early in the sixteenth century. It was in use on the coast, in the north among the Chimu and in the south in the Nazca region, before these countries were conquered by the Inca. At present it is impossible to establish earlier dates which are reliable. To the Peruvians gold was a material easily worked, plastic, and imperishable, well adapted for works of utility and art. It seems never to have been employed as currency and probably not even in barter; it was therefore set aside, at least in the Inca period, for use in the temples and palaces.

It was largely this difference in attitude toward the metal which amazed and overwhelmed the Spanish explorers. In Spain the use of gold as currency and for hoarding greatly restricted its employment in the arts. In Peru it was used for the arts only. Just what is the truth about the abundance of gold in Peru and the uses to which it was put is difficult to determine. There are many narratives of the period of the conquest and of the following century but these have never been critically treated. Some of the statements are quite improbable while others, which seem incredible, are so circumstantial and well supported that there is no valid reason for setting them aside.

Among the best authorities is the Inca, Garcilasso de la Vega. He was born in 1540 at Cuzco, the son of a noble Spaniard, a companion of Pizzaro, and of an Inca princess of the royal house, a first cousin of the king, Atahualpa, who was so treacherously murdered by the Spaniards. He spent the first twenty years of his life in Peru, travelled extensively throughout the empire, and recorded what he had heard at first hand from his Inca relatives and the numerous survivors of the conquest, whose language was his own; his narrative is fascinating in its simplicity and frank differentiation of what he had seen and what he had been told. It carries conviction of his honesty and veracity.

His statements are supported by many other contemporary authorities; among whom we may cite as peculiarly worthy of belief, Francisco de Xeres, secretary to Francisco Pizzaro, with whom he set sail from Spain in 1530; he went with Pizzaro to Cajamarca and was present at the capture and execution of Atahualpa. He describes in detail the Inca's treasure and the huge portion of it which, according to the ruler's promise, was brought together for his ransom; he

further narrates de Soto's journey to Cuzco, the capital, and Hernando Pizzaro's trip to Pachacamac and Jauja, with the treasures they found in those places. He returned to Seville in 1534 and in the same year printed his narrative.

His own share in the work is recounted by Hernando Pizzaro in a letter to "The magnificent Lords, the Judges of the Royal Audience of his Majesty, who reside in the City of Santo Domingo," which is dated November, 1533, when Pizzaro was on his journey home to Spain with the king's and his personal share of the loot. In further confirmation we have the official report of the notary, Pedro Sancho, giving a full list of the names of those who shared in the ransom of Atahualpa together with the amount of gold and silver each received. There are other confirmatory records.

From Francisco de Xeres we learn that after Pizzaro had massacred two thousand of the friendly and unsuspecting Peruvians and seized the person of their king, the monarch, realizing that the Spaniards were, as Cortez said, suffering from a disease which gold alone could cure, offered in order to ransom himself and his family to collect as much of the precious metal as would fill the room in which he was confined, 36 x 25 feet, as high as he could reach on its walls, probably over seven feet. This proposal was accepted, and messengers were sent to all parts of the kingdom to collect the treasure. The monarch fulfilled his promise faithfully; the ransom in question, when melted down for distribution, amounted to 3,933,000 ducats of gold and 372,670 of silver, a total of $17,000,000 or more in American coinage. When he found that this vast sum would not save him, the Inca offered an additional amount for his life. The conquerors, however, seeing how easily the first supply had been obtained, doubtless felt that the rest could be garnered without his help, and fearing a popular rising in behalf of the unfortunate monarch, murdered him.

An idea of the lavish use of gold under the Incas may be gained from Garcilasso's account of the Temple of the Sun at Cuzco. He says: "It is now the church of the divine Santo Domingo. As I have not the exact length and breadth, I do not give it here." From other authorities we learn that the precinct was about five hundred feet square. It was built of masonry, so well that the remains of its stone walls excite the admiration of all travelers to this day. Garcilasso says it was very lofty. "All the four walls of the temple were covered from roof to floor with plates and slabs of gold. In the side where we should look for the high altar, they placed a figure of the Sun, made of a plate of gold of a thickness double that of the other plates which covered the walls. The figure was made with a circular face and rays of fire issuing from it. . . . It was so large as to occupy the whole of one side of the temple from one wall to the other. . . . This figure of the Sun, when the Spaniards entered the city, fell to the lot of a noble knight, one of the first conquerors, named Mancio Serra de Leguisamo, whom I knew, and who was alive when I went to Spain." He goes on to tell how this knight gambled away this splendid loot at one sitting; and commenting on this one man's share, he says an idea may be formed of the magnitude of the treasure which was found in this one city and temple.

"On either side of the image of the Sun were the bodies of the dead kings, arranged according to priority, as children of that Sun, and embalmed so as to appear as if they were alive, although the process is not known. They were seated on chairs of gold, placed upon the golden slabs on which they had been used to sit. . . . The Indians hid these bodies with the rest of the treasure, most of which has not been brought to light up to the present time. In the year 1559 the licentiate Polo discovered five of the bodies, three of kings and

two of queens [and Garcilasso saw them].

"The principal door of the temple looked to the north, as it does now, and there were other smaller doors for the service of the temple. They were all coated with plates of gold. Outside the temple, on the upper part of the walls, a cornice of gold, consisting of a plate more than a yard wide, ran round the whole building, like a crown.

"Beyond the temple was a cloister with four sides, one of which was the wall of the temple [this was probably the court or precinct five hundred feet square]. All round the upper part of this cloister there was a cornice, consisting of a plate of gold more than a yard wide, forming a crown to the cloister. In place of this gold the Spaniards caused a cornice of white plaster to be put up, of the same width, in memory of the former one and I left it there in the walls, which were still standing. One of the halls was dedicated to the Moon, the wife of the Sun. . . . The whole of it, with the doorways, was covered with plates of silver. . . . The image, like that of the Sun, represented a woman's face on a plate of silver. . . . Another of these halls . . was dedicated to the planet Venus and the seven Pleiades and to all the other stars. . . . This hall was covered with silver like that of the Moon, and the doorway was of silver. The whole roof was strewn with stars, great and small. . . . The other hall was dedicated to lightning, thunder, and the thunderbolts . . . and the hall was lined with gold. . . . Another hall, which was the fourth, was dedicated to the rainbow, for they had ascertained that it proceeded from the Sun; and the King's Incas therefore adopted it as their device and blazon, as descendants of the Sun. This hall was all covered with gold. On one side of it, on the plates of gold, a rainbow was very naturally painted. . . .

"The fifth and last hall was set apart for the high priest and for the other priests who assisted in the services of the temple, all of whom were Incas of the blood royal. . . . This hall, like the others, was also plated with gold from floor to ceiling. . . .

Of the five images the Spaniards secured three, which still remain in their ancient positions. They only lost the benches of gold and silver and the images of the moon and stars, which had been pulled out of the ground.

"Against the walls of these temples, looking towards the cloisters, on the outside, were four porches of masonry. . . . The mouldings round the corners and along the inner parts of the porches were inlaid with plates of gold, as well as the walls and even the floors. At the corners of the mouldings were many settings of fine stones, emeralds and turquoises, but there were neither diamonds nor rubies in that land. . . . In two of these porches, built against a side facing to the east, I remember having seen many holes in the mouldings. . . I heard the Indians and ministers of the temples say these were the places in which the precious stones were fixed in the heathen times. The porches and all the doorways opening on the cloister, which were twelve in number, were inlaid with plates and slabs of gold . . . except those of the temples to the Moon and Stars . . . which had their doorways of silver.

"There were within the edifice five fountains of water. . . . The pipes were of gold, and some of the pillars were of stone, and others were jars of gold and silver. . . .

"The garden which now supplies the convent with vegetables, was in the time of the Incas a garden of gold and silver, such as they also had in the royal palaces. It contained many herbs and flowers of different kinds, many small plants, many large trees, many large and small animals both wild and domestic, and creeping things, such as serpents, lizards, and toads, as well as shells, butter-

flies, and birds, each in its natural position. There was also a large field of maize, the grain they call Qumua, pulse, and fruit trees with their fruit; all made of gold and silver. There were also in the building billets of wood, imitated in gold and silver, and great figures of men, women, and children, as well as granaries, called *pirua*, all for the ornamenting and the majesty of the house of the Sun, their god.

"Every year, on the occasion of the principal festivals, new objects of gold and silver were presented to the temple, so that its wealth continued to increase; for all the silversmiths, dedicated to the service of the Sun, had no other business than to make these things.

"There was also a vast quantity of pots, vases, and jars in the temple. In fine, there was in that edifice no article of any kind which was not made of gold and silver, even down to the spades and hoes for use in the garden. Hence, with good reason, they called the temple of the Sun and the building attached to it *Ccuricancha*, which means a 'court of gold.'

"In imitation of this temple of the city of Cuzco, others were made in the provinces, of many of which and of the house of the Select Virgins, Pedro de Cieza de Leon makes mention . . . though he does not mention all the temples. . . .

"Each *Curaca* (chief) was bound to adorn the temple in his district, in proportion to his wealth in gold and silver, as well as to serve and honor his God as to show respect to his king, who was a child of the Sun, so that all these temples of the provinces vied with that of Cuzco in their platings of gold and silver."

Regarding the temple on the island of Titicaca, in the lake of that name, on which the Sun placed his children, the first two legendary Incas, Garcilasso quotes Father Blas Valera to the effect that the Indians told him that there was so much gold and silver heaped up in it that another temple might have been built of the accumulation without recourse to any other materials. "But," says he, "as soon as the Indians heard of the invasion of their country by the Spaniards, and that they were seizing all the treasure they could find, they threw the whole into the lake."

There were usually fifteen hundred Virgins of the Sun, of necessity legitimate, and of the blood royal, but no rule limited their number; they had for attendants five hundred virgins, and all dwelt together in a convent, into which no one but the queen might penetrate. "All the furniture," says our chronicler, "down to the pots, pans, and jars, were of gold and silver; they had also a garden of gold and silver, like that in the temple of the Sun."

"There were many others like this convent in other parts of the kingdom."

The royal palaces, which were scattered over the vast empire, were walled and adorned with the precious metals within and without. "They did not have tapestries for the walls, for they were covered with gold and silver." Connected with the palaces were golden gardens like those in the temples of the Sun. All the vessels, large and small, for the whole service of the palace, including the kitchen, were of gold and silver. The baths, with the pipes for bringing the water, were of the same precious metals. The Inca usually sat on a stool of solid gold, a *tercia* in height, which was placed on a great square board of gold.

These things were in each royal lodging so that the Inca might not be under the necessity of carrying them about with him. When he died, his palace was left in statu quo, sacred to his memory. All his personal vases, jars, basins, kitchen service of gold and silver, and all his clothes and jewels were buried with him, and his successor began an accumulation anew.

There may be some exaggerations in these accounts, but that gold was freely

used for the decoration of temples, for the overlaying of the thrones of the Incas, and for the household utensils of their palaces can hardly be doubted.

The most incredible story of all is that of the golden chain or rather cable which Huayna Ccapac, the last of the great Incas, had made at the birth of his son, Huascar (*huasca*, without the sounding of the final r, means a cable; the Quichua language had no word for chain).[1] The Incas held a stately ceremonial dance in which as many as two hundred or three hundred men and even more participated, grasping hands. On the occasion in question Huayna Ccapac thought to increase the splendor of the function by having the dancers hold instead the golden chain. Says Garcilasso, "I had a special account of this from the old Inca who was my mother's uncle, Paullu Inca before mentioned. I asked him what was the length of the chain, and he told me it was twice the width and length of the great square at Cuzco." He goes at some length and with great detail into the dimensions of this square, which he knew intimately, and concludes that "the chain must have been three hundred fifty paces long, which is equal to seven hundred feet. When I asked touching its thickness, he raised his right arm and, putting out the thumb, said that each link was of that thickness." This chain was concealed on the approach of the Spaniards so that it has never been found; Garcilasso says that it was commonly reported that the Indians threw it into the lake of Urcos, about six leagues south of Cuzco, together with much of the treasure of that city. He gives an entertaining account of the vain endeavors of the Spaniards to drain that lake in 1557.

Unless we are to understand that the chain was merely gilded or contained golden insets, the amount of metal required for its construction hardly allows the story to be accepted. These early published stories of hidden gold and the many still current in Peru must be considered largely as legendary, imaginings prompted by desire. The fact that the golden treasures were concentrated in the palaces and temples made it easy for the Spaniards to gather them up and we may be sure they did not cease their efforts until they were no longer repaid by success. North of Peru, in Ecuador, Colombia, and Costa Rica, objects of gold were commonly buried with the dead and it is still possible to recover them. The location of graves and the digging of the treasure is a regular occupation in many localities. A small percentage of the graves of Peru still yield gold ornaments but not in commercially paying quantities. But this does not discourage either the dreams or the attempts to secure sudden wealth by finding the great Inca treasures.

The conflicts between the civilizations of the Mediterranean and the Andes resulted in the nearly complete destruction of the latter. With it the use of gold in art diminished and now the local interest is not in the skill and beauty displayed by the ancients but in the intrinsic value of the metals or what may be secured for them in exchange.

[1] "There appears to be no truth in the story about a golden cable having been made to celebrate his birth. The story was invented to account for the name. There had long been a cable covered with plates of gold, in use for the performance of dances during the great festivals." (*The Incas of Peru*, p. 241, by Sir Clements R. Markham.)

HOW DIAMONDS ARE POLISHED

BY
H. P. WHITLOCK *

SUPPOSE you were taking a walk somewhere in the middle of South Africa and, happening to glance down, saw at your feet a small, angular, irregular object, clear like glass but with a surface that looked as though it had been smeared with oil. You would probably kick it aside and proceed on your way; and yet this insignificant-looking thing might easily be a diamond of great value.

Diamonds as they are found in the rough state are not impressive. They have none of the magical flashes of light which in the finished stone make them unique among the noble family of gems. It is in polishing that a goodly part of the price of a diamond is acquired; for the art of turning a rough diamond into a glittering brilliant is a long process requiring a superlative degree of skill. There is no better way to appreciate this than to follow the diamond from the mine to the jeweler and see for ourselves just what happens to it.

When the diamonds are taken out of the mine, not by any means are all of them clear and colorless, as a self-respecting diamond should be; indeed only about 25 per cent of the stones found are without some faint color. Of the remainder about one third are of a light shade of color, such as violet, yellow, or brown, and are known as "off-color" stones. The remainder, roughly one half of the total find, are more or less deeply colored and are consequently of no value for jewelry although still usable for diamond cutting and polishing or for facings for rock drills. So we find that at the beginning of its travels the diamond is introduced to the sorter. The sorter is a kind of super-expert on diamonds whose eye has been trained through years of practice to detect the slightest variations in the color of diamonds and to find flaws in the stones with an ease which is little less than uncanny. Safeguarded behind a heavy metal screen, the diamond appraiser sits with a pile of rough stones before him, judging each stone and assigning it to its proper heap.

The first consideration in sorting diamonds is the adaptability of the stone for cutting. Let us assume that the stone whose travels we are following is sorted into the grade known as "close goods," comprising complete, flawless crystals from which fair-sized brilliants can be cut or, to use the trade term, "made." These usually have eight sides or faces, triangular in shape. Next comes a resorting of the "close goods" into eight grades, ranging from blue-white, which comprises the stones of finest quality, to yellow and brown, which are so badly off-color as to be unfit for gems. If our stone has passed the critical test of the sorter and has been placed in one of the higher grades, it is weighed, wrapped up in a parcel with others of its kind, a price per carat is assigned to it, and it is sold to a diamond dealer, and ultimately finds its way to the workshop of the diamond polisher. Here, at the hands of a highly skilled workman, it is destined to be turned into a gem fit to grace beauty or proclaim opulence.

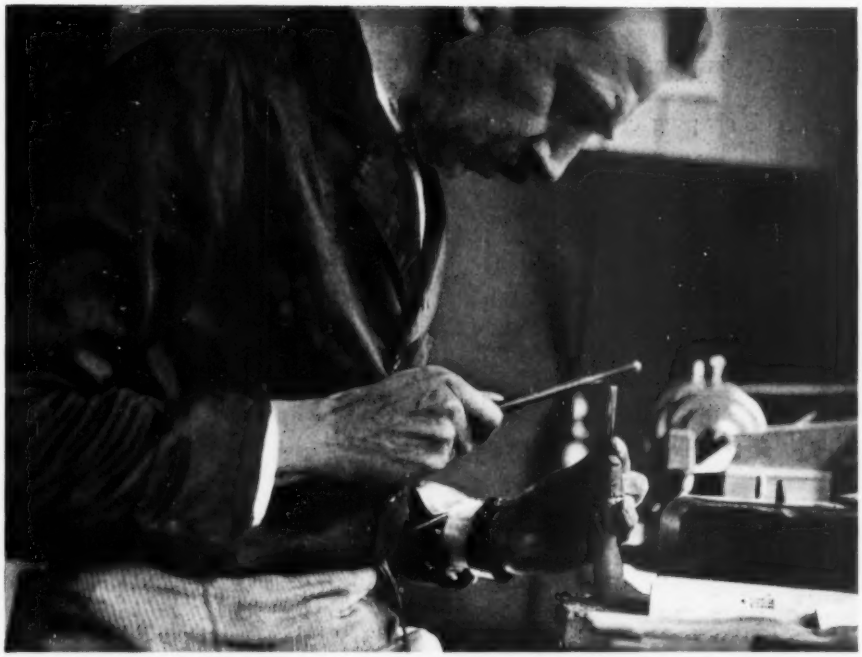
Most of this work is done in Holland, and especially in Amsterdam, which since the fifteenth century has been famous for this industry, in reality an art, but there are, nevertheless, a number of shops in operation right here in our city of New York. Like many other operators who depend for their success on a high degree of manual skill the diamond cutter has few tools, and these are relatively primitive and have changed little since the days of Louis de Bequem, who

* Curator, Department of Mineralogy, American Museum

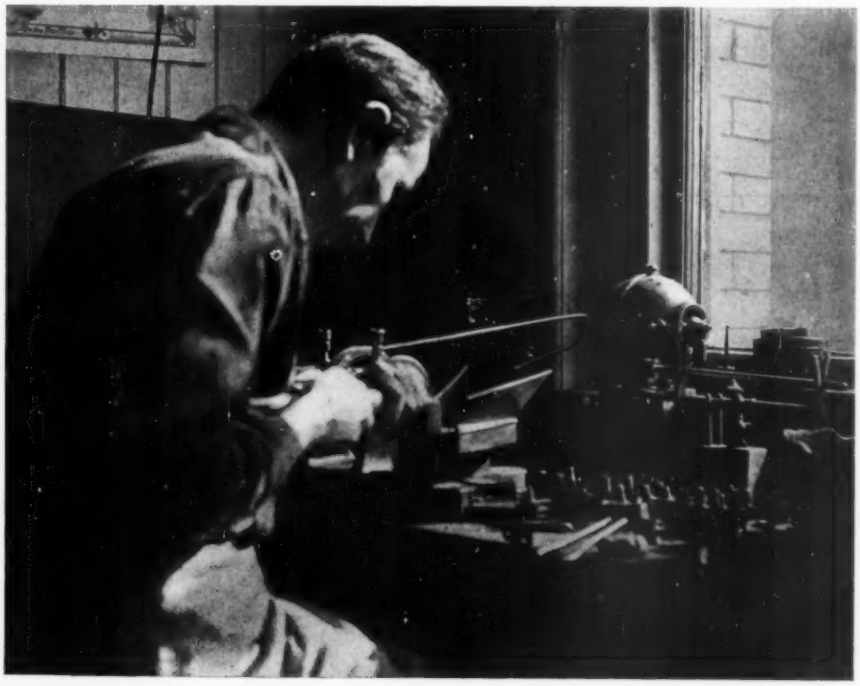
The tools of the diamond lapidary's art are very simple. The little metal cup or "dop," in which the diamond is being placed, as well as the wooden holder which carries it, are of exactly the same shape as those used by the diamond cutters of a hundred years ago

cut diamonds in 1475. The lapidary depends like the violin player on the delicacy of his touch, and like the painter on the accuracy of his eye, and he scorns to use complex mechanical devices to aid him in his difficult task.

The surface irregularities, together with any superficial flaws or dark patches, are first split away from the stone, which breaks naturally along smooth, even surfaces parallel to the natural faces of the crystal. To accomplish this our diamond is firmly cemented to the end of a wooden stick which in turn is made fast in an upright position, and thereupon with the sharp corner of a diamond fragment a deep scratch is made in the surface of the stone. A knife edge is then held in the right position on the scratch, and a sharp blow with a light tool on the back of the knife edge suffices to remove the undesirable flake, leaving the surface bright and very smooth. Sometimes, when the stone is large, it is of advantage to saw it into two or more pieces so as to save as much as possible of the weight in cut diamonds. This is accomplished with a thin disk of bronze, about four inches in diameter, revolving very rapidly and having its edge charged with diamond dust at the beginning of the sawing. As the saw bites into the stone, it keeps recharging itself with the diamond sawdust. It takes many hours for this little "buzz saw" to eat its way through half an inch of diamond, but the finished product is so valuable that a day or so of labor



Like a skilled surgeon the diamond lapidary performs the delicate operation which is known as "slitting." Just the right amount of the stone, no more and no less, must be split away. The intent expression on the face of the operator bears witness to the momentous effect of the slight blow he is about to strike on the steel knife edge which he holds in his left hand

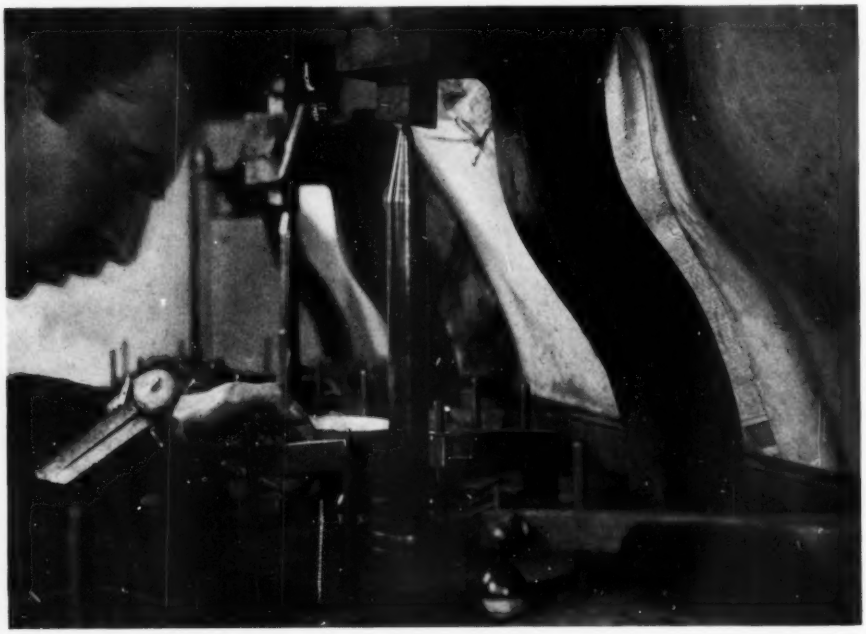


Even the refuse from this operation is valuable and must be saved. As the lapidary rough-shapes his diamonds, rubbing or "bruting" the one on the end of the long stick which he holds under his right arm, against the other on the rapidly turning spindle which is driven by the belt, the dust and fine fragments fall into the little box shown in the centre of the picture. Only the protruding end of the stick is visible in the illustration

makes little impression on the cost sheet.

The rough shaping of the diamond is done through an operation called "bruting," which consists of wearing away the corners by rubbing one stone against another. Formerly this was a strictly manual process, the two diamonds being mounted on sticks held in either hand by the lapidary. Even into the ancient and conservative art of diamond cutting, however, some mechanical improvements have made their way, and now in most of the shops a rapidly twirling spindle takes the place of one of the hand sticks. The remaining stick has grown in length to suit the modern method. It is now about two feet long and can be firmly grasped with both hands and held in a rest so that the diamond it bears at its end can be rubbed against its fellow, which is spinning around in front of it.

Having rough-shaped our diamond we now come to the finishing operation, the producing of the facets which give brilliancy and sparkle to it, an operation which is technically known as polishing. The holder of the stone during the polishing consists of a small metal cup on a long stem, which is called a "dop" and much resembles a tulip, which famous Dutch flower may have suggested its shape. A solder composed of one part tin and three parts lead is placed in the dop and heated until soft. The diamond is then embedded in the solder with the portion of the stone on which the desired facet is to be cut placed uppermost and almost completely surrounded by the solder. When the diamond has been properly adjusted in the dop, it is plunged in cold water to cool and harden the solder. Such drastic treatment would cause less aristocratic stones promptly to fly to pieces, but not so with the diamond; the high heat conductivity of this remarkable substance permits it to submit to the sudden change of temperature without there resulting in it even the slightest flaw.



The actual cutting of the facets on the diamond, known as "polishing," calls for the highest expression of the diamond lapidary's art. The stems of the "dops," which bear the diamonds, must be adjusted in the "tongs" with fine nicety. Here again the form of the tools has not changed in a century. The iron "tongs," the wheel and its spindle (shown in the centre of this picture), even the metal pegs against which the tongs are kept in place on the wheel, are the same as those used in Amsterdam and Antwerp in 1821

The dop is now fastened by means of its stem in a heavy iron arm called the tongs, in such a way as to bring the position of the facet to be cut exactly undermost when it is placed in contact with the polishing wheel or lap. The latter is made of soft iron and turns horizontally at the rate of about one thousand revolutions a minute. Diamond dust, mixed with olive oil, is fed to this wheel and the diamond is held in contact with it by weight of the tongs, aided by slabs of lead placed upon the latter. Several hours are required to cut one facet, then the stone is readjusted for another one, and so on until all of the fifty-eight little facets in which lies the secret of the brilliancy of the jewel are produced.

To appreciate the exquisite skill and infinite patience involved in this apparently simple process we have only to look at the gem on our finger, sending forth its magical fires, and to note the symmetry and regularity of shape of each of its tiny, glittering sides. And when we remember that to produce these rainbow-like rays each must have exactly the right tilt with respect to its neighbors, we realize that a cut diamond is not only a wonderful product of nature but a marvelous work of art.

Before the introduction of methods of diamond cutting in the fifteenth century, diamonds, when used in jewelry, were set with four of the eight sides of the octahedron or double pyramid projecting from the setting. This presented the aspect of a four-sided pyramid, and the exposed faces or facets were sometimes polished. The next step in the evolution of the modern form of diamond cutting was the production of a flat "table" on the exposed point by rubbing or "bruting" two crystals together. Thus we have the origin of the table facet as it is known today. In the early seventeenth century when the art of the diamond cutter had somewhat advanced, a more symmetrical outline for the stone was obtained by cutting away the four edges of the pyramid above the setting, which of course necessitated the equal cutting away of the four edges below. This gave eight facets grouped about the table and eight below the "girdle," as the line encircling the stone at the point of the setting is called. At a previous stage in its development a small facet called the "culet," directly opposite the table, had been introduced, so that we have for this cutting, which has sometimes been called the single-cut brilliant, a total of eighteen facets.

Up to this point in the development of diamond cutting, stones were cut for symmetry of outline alone and no attempt was made to utilize the remarkable optical properties of the diamond, which enable it, when properly proportioned in the cutting, to reflect back to the eye most of the light which falls upon it. Toward the close of the seventeenth century Vincenzio Peruzzi, a Venetian, began to cut diamonds on this principle. With this discovery, no longer the lapidary labored solely to produce a maximum weight and symmetry of outline, but he endeavored to combine with these the very essential factor of the brilliancy of the stone. And with increased skill in the art, more facets were added to beautify the form and enhance the radiance of the gem. Sixteen additional "corner facets" above and sixteen below the girdle rendered it rounder and more symmetrical, and subsequently eight extra facets grouped about the table completed the fifty-eight of the modern brilliant.

It is a singular and somewhat significant fact that the historical evolution of the modern brilliant as here traced is precisely its actual evolution under the hands of the diamond cutter. The facets are added to the stone in just the order in which they were developed through the centuries.

THE PITCHER PLANT, *Sarracenia flava*

Though many insects are lured to their death by this plant, from whose nectar-baited pitchers they never emerge, it in turn is victimized by a moth that lives, immune, in association with it. The drooping pitchers here shown have been collapsed by the larvæ of that moth (*Exyra ridingsii*) just before pupating, the collapsed pitcher closing the tube above and giving additional protection to the helpless pupæ

PITCHER PLANTS AND THEIR MOTHS

THE INFLUENCE OF INSECT-TRAPPING PLANTS ON THEIR INSECT ASSOCIATES

BY

FRANK MORTON JONES

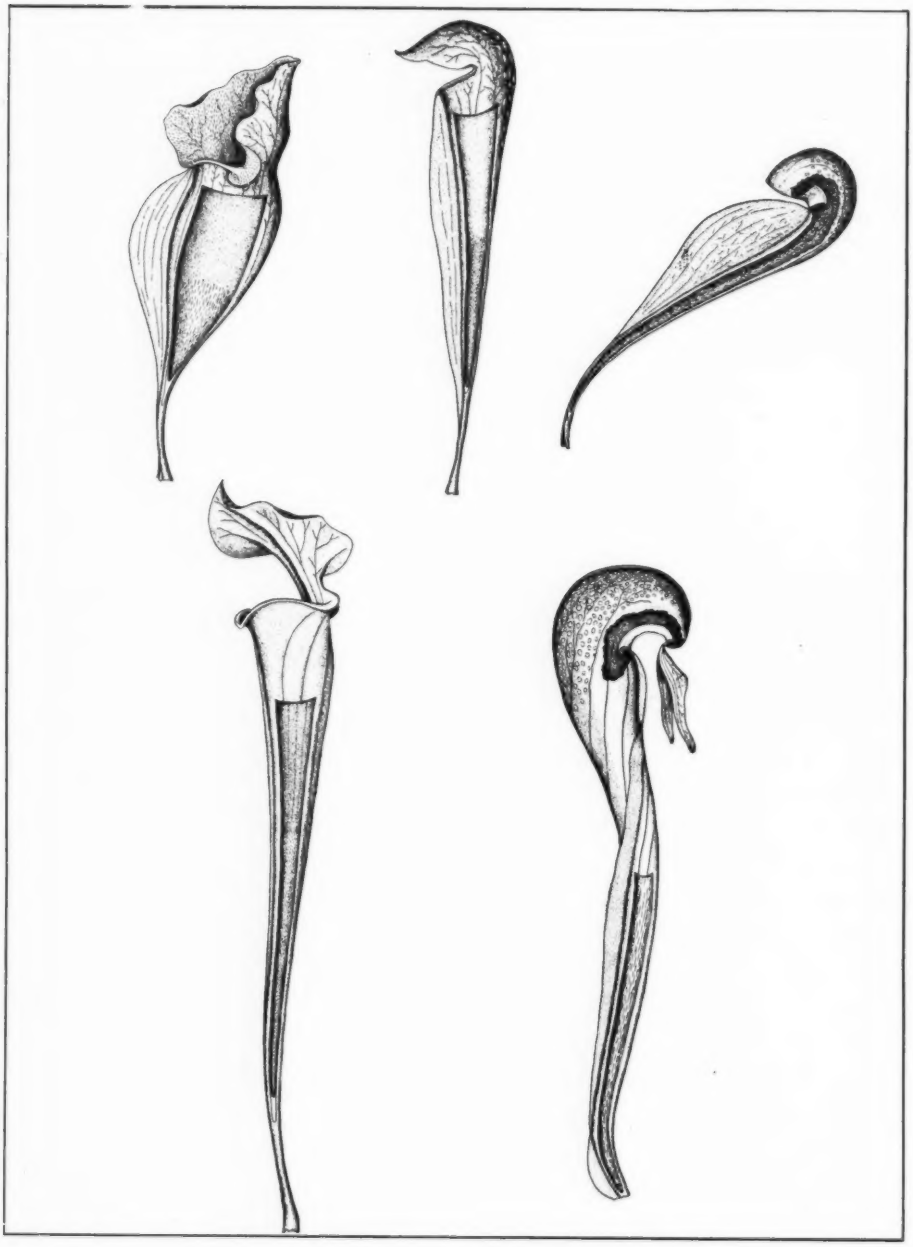
IT is most obvious that in the development of the higher plants and of the insects each has had great influence on the other. Floral colors, fragrance, nectar secretion, structure—all the complicated adjustments to secure insect pollination—are matched in the insect world with modified mouth parts, pollen-gathering and nectar-storing structures, specializations of instinct with reference to the utilization of flower products. Even more generally the food-plant relation, usually detrimental to the plant, is of obvious significance and importance to the insect. Thus, by the almost innumerable plant-insect relationships, either both plant and insect benefit or the insect benefits at the expense of the plant.

In rare instances these conditions are reversed; the plant, instead of being eaten, becomes the devourer. These insectivorous plants, representing a unique point of contact between the plant and insect worlds, show resultant complicated adjustments. If a restricted group of insectivorous plants has long been in contact with a restricted group of insects, we may with reasonable certainty expect to find the specialization of the plants as insect traps in some degree met by insect specialization to evade or even to utilize these traps. Do the insect associates of insectivorous plants exhibit any definite change of structure or of instinct resultant from their contact with these plants?

In America north of Mexico we have a number of types of insectivorous plants—notably the sundews, *Drosera*, Venus's-flytrap, *Dionæa*, and the pitcher plants, Sarraceniaceæ,[1] a purely American family containing three genera and nine species. Of the Sarraceniaceæ one genus and species, *Heliamphora nutans* Bentham, has been recorded only from Mount Roraima, on the borders of British Guiana, and in its native home has been seen only a few times by civilized man; one genus and species, *Darlingtonia* (or *Chrysamphora*) *californica* Torrey, inhabits mountain bogs of northern California and southwest Oregon; and of the typical genus, *Sarracenia*, seven species are found in the southeastern United States, only one of these seven, *purpurea*, ranging north of Virginia to Labrador.

The leaves and petioles of all the North American Sarraceniaceæ are modified into hollow structures, or "pitchers," which exhibit many specializations as insect traps. The accuracy of this interpretation of these structures has been questioned from time to time, but no other explanation of them seems to us admissible. Quite generally, by non-botanical observers, their pitchered leaves are classed as flowers. They are all more or less brilliantly colored—striped, veined, or reticulate with purple-red, sometimes on a white or yellow ground. They exhale a fruity or honey-like fragrance. All of them secrete a sweet fluid containing fruit sugar from numerous nectar glands so distributed that insects are enticed to the rims of the pitchers and thence inside. In most species inward directed hairs offer additional guidance. Once inside the pitcher, the insect steps upon the smooth "conducting surface" and is precipitated to the bottom of the tube, from which escape is barred by long, elastic, downward-directed hairs. In some species escape by flight is further discouraged by a series of translucent "windows," which stud the hood on the side farthest from the orifice of the pitcher. The pitchers of all the species, at their

[1] Macfarlane: Sarraceniaceæ, in Engler, *Das Pflanzenreich*, 34 Heft (IV. 110), Leipzig, Engelmann, 1908



THE FIVE TYPES OF PITCHERS OF NORTH AMERICAN PITCHER PLANTS

Purpurea *Minor* *Psittacina*

Flava *Darlingtonia californica*

most active period as insect traps, contain a clear fluid, which in some is purely a plant secretion but which in others, by their structure more exposed to the weather, is usually greatly diluted with rain water. In at least four species this secretion has the quality of quieting or stupefying captured insects, whose struggles usually cease within a very few seconds after capture. In six of our eight species it has been shown that the fluid contains a protein-digesting enzyme, active to extreme dilution; they also invariably contain proteolytic bacteria. The quantity of the secreted pitcher liquor is greatly increased by food stimulation, and from it both liquids and nutrient solids in solution are rapidly absorbed by the pitcher walls.[1]

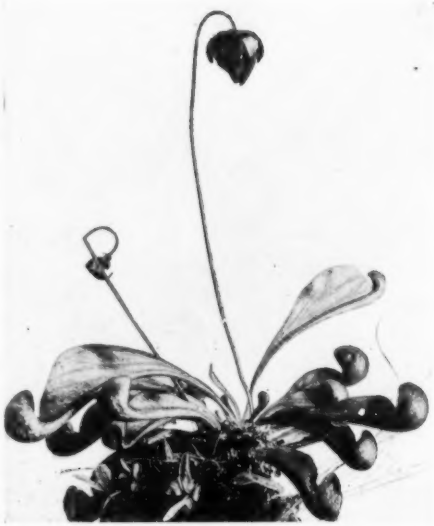
If further evidence were necessary that the pitchered leaves of the Sarraceniaceæ are specialized insect traps, their efficiency as such would seem conclusive, for especially the larger southern species often capture insects in almost incredible numbers. The bulk of these captures usually consists of Lepidoptera, Coleoptera, Hymenoptera, and Diptera; but all the principal orders of insects are represented, as well as spiders of many species, occasionally mollusks and crustaceans, and even some small vertebrates (tree frogs and lizards) whose remains occur in the mass of captures, which frequently fills the pitcher tube to the height of several inches.

Structurally our eight species exhibit five different types of pitchers. In *Sarracenia purpurea* Linn. the pitcher is wide in proportion to its height; the hood or "operculum" is vertical. The wide mouth is thus almost fully exposed to the weather, and the pitchers are usually full, or partly full, of rain water. In *Sarracenia flava* Linn., *S. sledgei* Macf., *S. drummondii* Croom, and *S. rubra* Walt., the pitchers are tall, slender, more or less tapering and trumpet-shaped; the hood is lidlike, partly overhanging the mouth, and although beating rains sometimes gain access, only the narrow, basal portions of these pitchers normally contain fluid. In *Sarracenia minor* Walt. (*variolaris* Michx.) an overarching, helmet-shaped hood practically excludes rain water. In *Sarracenia psittacina* Michx. the pitchers are recumbent, and the narrow, tubular pitcher orifice is concealed beneath the closed hood, shaped like a parrot's beak. In *Darlingtonia* the pitcher orifice opens upward into an expanded, bladder-like hood, and a cleft appendage hangs from its anterior rim.

In some degree these and other structural differences are explicable as adaptations for the capture of special groups of insects. The captures of all the species, however, are most varied. These captures obviously consist not only of nectar-loving insects attracted by the bright colors, the fragrance, and the nectar bait, but also of many others whose presence cannot thus be explained: carrion-feeding species attracted by the odor of the mass of previous captures, predacious and parasitic insects whose habit it is to search every nook and crevice, insects of blundering flight—locusts and heavy-bodied beetles—which form a considerable proportion of the mass of insect remains. All of these begin to accumulate as soon as the new pitchers open in the spring.

Obviously, then, with their captures including so large a representation of the insect fauna of their habitat; with the plants themselves, sometimes occurring in almost pure stands over considerable areas, yet notably of restricted distribution and habitat; we can scarcely expect to find among their insect captures any significant adjustment to what must be for any given species an occasional and local, rather than a relatively frequent and general, source of danger. These plants, however, in addition to their insect captures have many insect associates. Their flowers exhibit intricate

[1] "The Absorption of Nutrients and Allied Phenomena in the Pitchers of the Sarraceniaceæ" by Joseph S. Hepburn, E. Quintard St. John, and Frank M. Jones in *Journal of the Franklin Institute*, Vol. 189, No. 2, February, 1920.



The low-growing, almost aquatic *Sarracenia psittacina* in times of temporary inundation captures great numbers of water beetles, whose polished bodies are gripped by the densely placed, long, elastic bristles which line its tubes

The exposed pitchers of *Sarracenia purpurea*, usually filled with rain water, often buried to their lips in the deep sphagnum in which they delight to grow, are pitfalls for ground-inhabiting insects, though their captures are by no means restricted to such species. This, the most familiar of our pitcher plants, as an insect trap is less uniformly successful than other species, though at least the narrow tubular basal portions of its pitchers are usually packed with insect remains

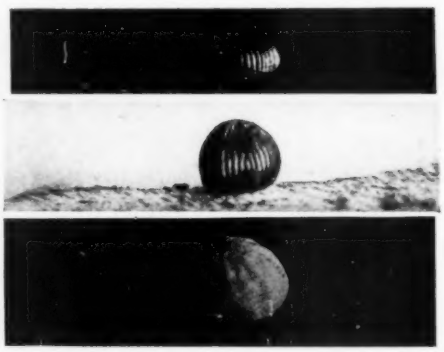
Sarracenia minor usually grows in a drier situation than *purpurea*. It has a baited pathway from the ground to the pitcher's rim. Its drier pitchers are often literally stuffed with the bodies of ants

The showy tops and flattened lids of *Sarracenia drummondii* (on right), *Sarracenia flava* (in center), and *Sarracenia sledgei* (on left)—fragrant, nectar-baited, conspicuously raised above the surrounding vegetation—form natural alighting places for the flying insects which largely constitute their prey. Well developed pitchers of these species usually exceed twenty inches, quite frequently thirty inches, in height. The picture of *Sarracenia sledgei* is here reproduced by courtesy of the *Journal of the Franklin Institute*

adaptation to secure insect pollination. The flower, the flower stem, the unripe and the ripe ovary, the fleshy rootstock, each forms the food of one or more insect species, which, however, do not come into frequent or necessary contact with the insect-catching devices of the plant. The pitchers themselves, like many other hollow, vegetable structures, are utilized as homes by certain nest-building Hymenoptera. The mass of insect captures in the pitchers offers too rich a supply of animal food to have been overlooked, and in seven of our eight species we find this material constituting the larval food of sundry dipterous insects—some of them exclusively pitcher-plant insects, and including representatives of the families Culicidæ, Chironomidæ, Mycetophiladæ, Phoridæ, Sarcophagidæ, and Chloropidæ.

Among these insects we find numerous examples of apparent adaptation, of both structure and instinct, to their uniquely dangerous habitat; and the degrees of adjustment to this environment, as exhibited by these insects, are most suggestive of the steps by which it has been obtained. The most unmistakable evidence, however, that the peculiar characters of these plants have been a significant factor, if not the most important factor, in determining the course of the evolution of some of their associated insects, is presented by a little group of noctuid moths belonging to the genus *Exyra* Grote, whose entire life cycle is passed in most intimate contact with these plants.

Of the three species[1] of *Exyra*,—*rolandiana* Grt., *ridingsii* Riley, and *semicrocea* Gn.,—*rolandiana* is the constant associate of *Sarracenia purpurea*, from Canada to the Gulf of Mexico; *ridingsii* Riley, of *Sarracenia flava*, from North Carolina to southeastern Alabama; and *semicrocea* Gn., the most adaptable of them all, seems equally at home in *Sarracenia rubra*, *S. minor*, *S. drummondii*, *S. sledgei*, and *S. psittacina*, its range extending from North Carolina to southern Mississippi,—probably into Texas with *sledgei*,—for the range of each species seems to be coincident with that of its associated food plant. These three insects exhibit adjustments, common to them all, which relate to the general plan of the insect trap of *Sarracenia*, indicating an association antedating the splitting of the insect group, if not the plant group, into several species; and they show further adjustments, each species to its own food plant, indicating that this process of adjustment has continued, either coincident with the development of the plant species or at least following the insect's association with these plant species. This will become apparent by considering the plant-insect relation stage by stage in the life cycle of the insects.



Magnifications of the eggs of *rolandiana* (topmost), *semicrocea* (middle), and *ridingsii* (lowest)

These eggs are deposited by the parent moths on the inner walls of the *Sarracenia* pitchers, usually some distance below the mouths

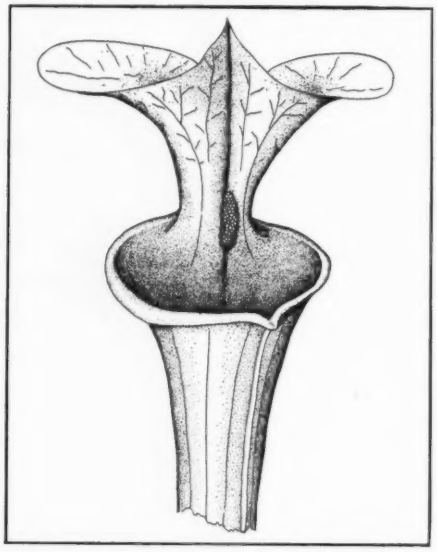
The eggs of *rolandiana* and *semicrocea* are of the usual noctuid type—yellow or yellowish green, polished in texture, dome-shaped, and vertically corrugated; that of *ridingsii* is larger, white, unpolished, much more flattened basally, and shows only faint indications

[1]Four species are recognized in the check list of Lepidoptera. In the opinion of the writer, however, *fax* Grt. and *rolandiana* Grt. are almost certainly identical. The better known name *rolandiana* is retained in this article, for it is possible, though extremely improbable, that *fax* Grt. may be found again as a rare and local species.

of a few broad, shallow, and less regular corrugations. Such a departure from the general type of its group and from that of its own genus would seem to have some significance. As a suggestion, and not as a theory, it may be stated that the great trumpet-shaped pitchers of *flava*, in which these eggs are deposited, in the early season exude an exceptionally abundant nectar bait, which gathers in drops on the hood and throat and runs down the walls of the pitcher, where it evaporates to dryness, leaving a white, sugary incrustation which persists for weeks; and the slightly wrinkled, dull white, flattened egg of *ridingsii* bears resemblance to one of these dried nectar drops. This resemblance can be of use only if it offers some protection. Although ants frequent the pitchers for nectar, and although spiders are often, and small acarids usually, present in the pitchers, the only observed enemy of *Exyra* eggs is a minute egg parasite, a *Chalcis*, which sometimes destroys a very considerable proportion of the eggs of *semicrocea*, but which has not yet been found in *ridingsii*. Would a female *Chalcis* in search of noctuid eggs fail to recognize an egg which departs from its type?

The eggs of *ridingsii* and *semicrocea* are deposited singly; for, as will appear, it is of vital importance that only one larva should occupy a pitcher, and when more are present, one drives out or kills the other; the eggs of *rolandiana* are deposited in groups of five or six up to as many as fifteen, to a pitcher, but only one such lot to a plant. Why? Of all the *Sarracenia* only *purpurea*, the food plant of *rolandiana*, has in its habit of growth a considerable number of pitchers in close contact—usually so close that their shape is distorted by mutual pressure; and from these short, wide pitchers growing thus in dense, interlaced masses, even very young larvæ may scatter and find their way, with a very few seconds' exposure, from pitcher to pitcher. In *flava*, *rubra*, *drummondii*, *sledgei*, and *minor*, the food plants of *ridingsii* and *semicrocea*, the pitchers are taller and much more separated in their habit of growth, so that traveling from one pitcher to another becomes a long and dangerous journey for a small larva—a journey not to be undertaken except under the compulsion of failure of food supply or at the time of pupation. In the one instance it is better for the species that the parent moth should not expose herself by too frequent flight and search for perhaps widely scattered clumps of *purpurea*, for the larvæ can readily change from leaf to leaf before their increasing size necessitates sole occupancy of a pitcher; in the other, flight from pitcher to pitcher, which though not in contact, are usually found in close proximity over wide expanses, is better than the long exposure of a young larva in a journey from one tall pitcher to another. Thus the habit of growth of the food plant determines the egg-laying habit of the associated insect.

In their larval stages these insects exhibit a succession of unmistakable adjustments to their plant habitat. The older larvæ of all three species have the common habit of protecting themselves from the attacks of parasites, spiders, and predacious insects, and to some extent from the weather, by closing the mouths of the pitchers they inhabit with closely spun, silken webs, then of feeding on the inner surface below the webs without piercing or rupturing the walls, which though thus eaten away to a thin, bladder-like condition, provide them with a closed feeding chamber, with perfect concealment and comparative security against intrusion from without. They exhibit but slight diversity of method in spinning the ceiling web. With *rolandiana* in *purpurea*, *ridingsii* in *flava*, *semicrocea* in *rubra*, *sledgei*, and *drummondii*, the fine, close, almost transparent web is spun horizontally across the throat of the pitcher, at



Flava is characterized by a deeply incised groove in the throat of the pitcher. The newly hatched larva of *ridingsii* creeps to this groove and constructs over a portion of it a cradle-shaped or hammock-like shelter of silk and corky frass particles, beneath which it lives for a few days, feeding on the portion of the pitcher thus covered and the immediately adjacent parts. No other *Exyra* constructs such a shelter

Pitchers of *sledgei* which young larvæ of *semicrocea* have converted into closed feeding chambers by girdling.

or slightly below the lips. Accidental tears and punctures of the pitcher walls are also ceiled, broken webs are replaced, and a larva placed in a cut section of a pitcher promptly ceils both ends. In the hooded leaf of *minor*, *semicrocea* sometimes follows the same method, but often curves the web upward and forward into the apex of the hood, or more rarely connects the lateral margins of the hood and the lips with an almost vertical web. In *psittacina*, *semicrocea* simply ceils the small, hidden leaf orifice, thus providing a closed feeding chamber with the least possible expenditure of silk. All these departures from the usual method, made possible in each case by the structural peculiarities of the food plant in which they occur, result in securing a larger leaf area for feeding under the protection of the silken web and in lessening the chance that a failure of food might necessitate a change to another pitcher.

It is beyond the power of a minute, newly hatched *Exyra* larva, however, to ceil the mouth of a large pitcher with silk. The first-stage larvæ of *ridingsii* (the largest species) are, for example, about 2.6 mm. ($\frac{1}{10}$ of an inch) in length, and the flaring mouth of the pitcher of *flava* in which they hatch may be 75 mm. (3 inches) across. At this early age, translucent, almost colorless, half buried in the plant tissue and surrounded by the refuse of their feeding, they are extremely inconspicuous, and within the pitchers they must possess some degree of immunity from the usual enemies of young caterpillars. Where the age and structure of the pitcher permit, however, they adopt further means of defense, as indicated in the illustration above.

The spring generation of *semicrocea* emerges from the egg when many of the pitchers of its food plants are tender and immature—hermetically sealed, spear-shaped tubes, pushing their way up to their full height before the lips of the pitchers open and they begin to function

as insect traps. The young larva finding a pitcher in this condition, ensures the continuance of a closed feeding chamber as follows: below the yet unopened lips of the pitcher, on the inside, it cuts one or more narrow encircling grooves—the groove cut by the newly hatched larva is so narrow and thread-like that it can be detected only by holding the leaf to the light. If the leaf be sufficiently tender, the portion above the groove quickly dies, contracts, and hardens, forming a tough, unbroken cap or lid to the still growing and expanding pitcher; and as this cap includes the pitcher's mouth area, a closed feeding chamber is thus created and maintained, providing the insect with food and protection through its most defenseless period; for having fed for some days in the closed chamber thus created, it is then large enough to effect a rapid change, if necessary, to an older and larger pitcher, which it quickly ceils with a silken web. This groove-ceiling is sometimes attempted in pitchers too old to respond, in which case the larva, as soon as may be, resorts to the web-ceiling method, expanded pitchers with ineffective grooves and typical ceiling webs being of common occurrence. The young larvæ of *semicrocea* employ this groove-ceiling method of maintaining a closed feeding chamber, whenever the pitcher conditions permit, in all five of their food plants.

Sarracenia purpurea, probably to a greater extent than any other species, produces new, and consequently unopened, pitchers more or less throughout its growing season, though more abundantly in the spring and late summer; and in these pitchers the young larvæ of *rolandiana* follow identical methods; but with this species the groove-ceiling operation serves for defense through two very different periods of the life cycle. All three *Exyra* pass the winter as larvæ in the pitchers of *Sarracenia;* but as the structure and winter condition of the different pitcher plants are so var-

Pitchers of *Sarracenia purpurea* the one normal, the other groove-girdled by the larva of *Exyra rolandiana*. The enclosure thus formed, which in the springtime would be utilized as a closed feeding chamber soon to be destroyed by the rapidly growing larva, in winter constitutes a dry, bladder-like hibernaculum, where the semilethargic larva, in the warmer periods, may do a limited amount of nibbling at the thickened walls without destroying the efficiency of its more or less water-proof compartment

ied, to ensure shelter and safety through this period of helplessness and enforced inactivity requires very different preparation on the part of the larvæ, and accordingly we find widely different methods in the construction of their hibernacula.

The wide, open-mouthed pitcher of *purpurea*, throughout much of its geographical distribution subject to winter conditions severe enough to convert the water filling its pitchers into solid cores of ice, its low growth and almost aquatic habitat often subjecting it to partial or complete submergence, offers to the hibernating larva of *rolandiana* an apparently difficult problem; but when, in the late summer, a young larva of this species groove-ceils a *purpurea* pitcher and then, preliminary to hibernation, ceases to feed and grow (for the winter is passed as a third-stage larva or younger), the pitcher walls, unmutilated by feeding, thicken and toughen to a

Low in the narrow, tubular, basal portion of the *flava* leaf the hibernating larva of *ridingsii* constructs its winter quarters. In this chamber the larva is well insulated against cold and excessive moisture

leathery consistence and serves as a hibernaculum.

Not all the hibernating larvæ of *rolandiana* find pitchers suitable for the girdling process. Any time from November to May, if we burrow with our fingers into the moss in which *purpurea* is growing, and lift the plants out bodily, in addition to the old and mature pitchers radiating from the apex of the rootstock, we may find one or several small, succulent, pinkish white, unopened leaves, too short to have yet pushed their way up through the surrounding sphagnum; and the slightly nibbled top of one of these immature leaves, with a flimsy, silken web flecked with bits of reddish brown frass closing the tube, is a usual indication of the presence of a hibernating larva. If no leaf suitable for either of these methods be available, the larva descends to the very bottom of an old, dry pitcher, and with silk and refuse partitions off a little, conical chamber in this narrow, lower extremity of the tube.

Ridingsii in *flava* is confronted by a problem quite different. Though taller and more erect, and usually growing in a drier habitat than *purpurea*, the pitchers of *flava* die to the ground in winter, and their flaring upper portions, dry and brittle, are almost sure to be split and shredded by the winter winds. In *flava*, in the late summer, no tender, unopened leaves are available for groove-ceiling, and there are no immature pitchers at the base of the plant. A different method of preparation for hibernation is necessitated by these conditions. The larva of *ridingsii*, feeding freely in the upper part of a *flava* pitcher, fills the lower portion for several inches with fine, corky débris and frass. In this material it constructs an arched chamber often several inches in length—the floor of compacted refuse, for walls the tough, dry, thickened basal portion of the pitcher, the roof a smoothly arched, compacted mass of corky frass and fine refuse strengthened with silk, above which the packed frass may extend for several inches.

With *semicrocea* the problem of winter survival changes again. In *rubra*, *minor*, *drummondii*, and *sledgei* the pitchers are erect. They usually grow in drier situations than *purpurea* and are thus not so subject to inundation; their leaves are comparatively free from rain water; and some of them remain green and unwithered, or partly so, throughout the winter, thus providing springtime food for the hibernating larvæ, suitable quarters for pupation, and even shelter for the emerging moths long before the spring growth of *flava* is available for *ridingsii*, which, remaining in its hibernaculum until the growth of new pitchers in the spring provides it with fresh food, is

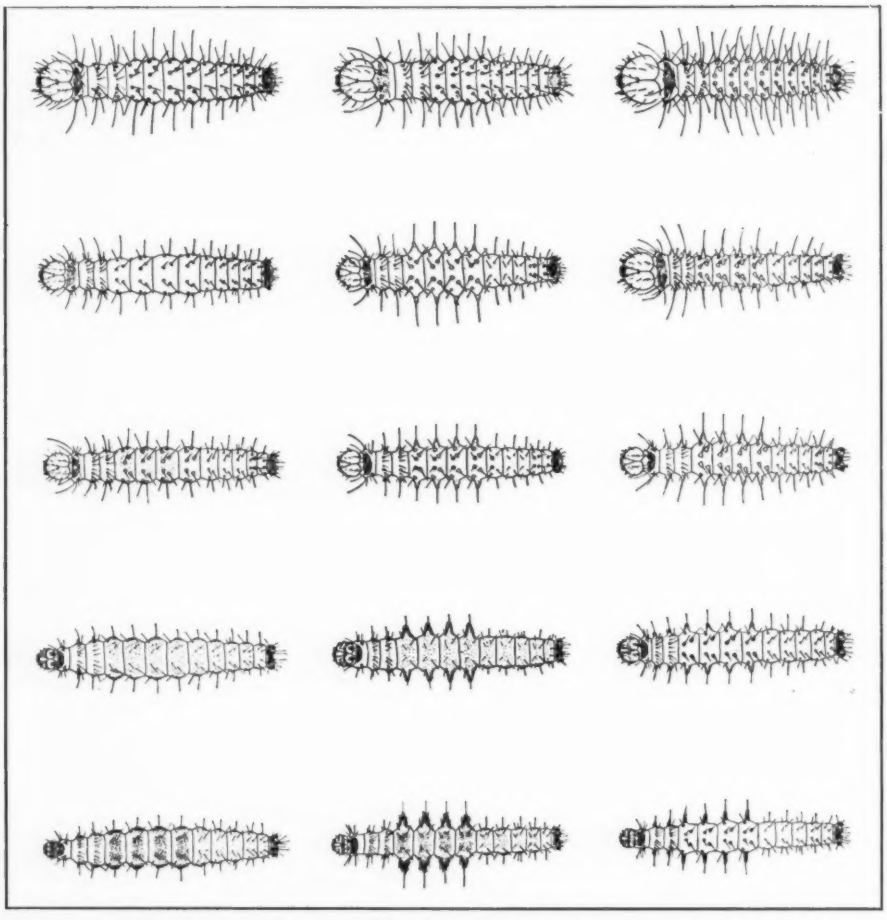
thus a month later in completing its transformations; that is, the seasonal history of the food plant determines the time of appearance of the associated insect. In these erect, green pitchers the larva of *semicrocea* prepares its hibernaculum by spinning a dense, opaque web across the tube, usually considerably below the throat, even halfway down; the web is sometimes thickened and made more opaque by the addition of fine, chewed fragments, or it may consist of pure white silk. Beneath this, most frequently as a last-stage larva, *semicrocea* hibernates.

One significant and interesting variation from this method, however, must be noted: in the low-growing pitchers of the almost aquatic *psittacina*, which, though rain-proof, are often subject to inundation, the young larva of *semicrocea* plugs the narrow, tubular entrance of the pitcher with a tough, thick, button-like wad of silk and chewed fragments. This converts the pitcher into a water-tight compartment even capable of withstanding submergence, thus similar in function, but not in origin, to the girdled, bladder-like hibernaculum of *rolandiana* in *purpurea*. In these pitchers the larvæ hibernate at an early age, not later than the third instar. Thus in *semicrocea* the age at hibernation, as well as the character of the hibernaculum, seems to be influenced by the food plant.

The flower buds of *Sarracenia*, formed in the late summer or early fall, are all ready to push their way upward at the approach of spring, with, or even before, the spring leaves, and they shoot up rapidly, sometimes at the rate of an inch a day. The same warmth which starts the flower buds racing upward also arouses the *Exyra* caterpillars in their hibernacula, for the green, succulent buds and expanding blossoms are the favorite spring food of these larvæ. Creeping up the stem, they bore into the globular flower bud, and the overlapping layers of expanding sepals and petals soon hide the entrance hole. In feeding, they avoid the outer layers, web together accidental apertures, and desert these shelters only when the food supply is exhausted, or for pupation. In older blossoms their procedure is similar, except that on entering they close the natural openings of the flower with silken webs or else block off a portion of the interior with such a web, under the shelter of which they demolish the fleshy parts of the flower and ovary. Flowers and buds are thus available only in the springtime, and then for only a fraction of the number of hibernating larvæ.

The behavior of the newly hatched larvæ in immature pitchers, and of older larvæ in open pitchers, has already been described. On leaving their hibernacula in the spring, the larvæ of *ridingsii* and *rolandiana* are of the third instar, ready to feed voraciously and grow rapidly to the time of pupation. For them the groove-ceiling procedure of the newly hatched larvæ would not be effective, for before the groove could produce a closed feeding chamber their voracious feeding would have wrecked the top of the pitcher. *Ridingsii*, creeping out from its dry-stem hibernaculum about April 20 (in South Carolina), finds its food plant, *flava*, in full bloom. If it finds an unoccupied bud or blossom, this provides it with sufficient food to complete its larval growth without further change. At this date the new pitchers of *flava* are slender tubes, pointed and entirely closed at the top, pushing their way up through the dead, dry leaves of the previous season. The larva of *ridingsii*, not readily finding a bud or blossom, creeps up one of these immature, tubular pitchers, and eating a hole just large enough for entrance, creeps inside. This process occupies only a few minutes.

Once inside, spinning a ladder of silk as it climbs the vertical walls, the larva creeps up into the closed peak of the hood, where its first feeding on the inner surface from the apex downward re-



Larval stages, from the egg to maturity, of the three species of *Exyra*, with special reference to the divergent development of ***rolandiana*** (left row) on the one hand, and *semicrocea* (middle row) and ***ridingsii*** (right row) on the other. Note in the two species last mentioned the development in the successive molts of the "lappet tubercle," Kappa (IV), and the absence of this character in *rolandiana*. These "lappets" keep their possessors from too intimate contact with the pitcher walls

sults in the drying up and toppling over of the whole upper portion, effectually preventing the pitcher's mouth from opening and ensuring a permanently closed tube which may be maintained in this condition with a minimum expenditure of silk in webbing over accidental openings. *Rolandiana* adopts a similar method in the tender new leaves of ***purpurea;*** and all intergrades between wide open, older pitchers ceiled with horizontal webs and tender, new pitchers ceiled by feeding and patching may be found.

The larvæ of *Exyra* present some unusual characters for noctuid larvæ, which, excepting the flower-feeding ones and other brightly-colored, exposed-feeding types supposed to exhibit warning coloration, are usually of dull colors, brown or gray, and without horns, prominent tubercles, or a hairy coating. *Exyra* larvæ vary individually from brown to more usually purplish red or even to bright wine-red, and are white between the segments; consequently their colors to a considerable degree match the red veins and mottlings of

their food plants. They are all more or less pubescent—*rolandiana* the most, *ridingsii* the least—and they all have the habit, when disturbed, of retreating down the pitcher wall or of releasing their hold and falling to the bottom. If in its descent *rolandiana* is precipitated into the water-filled pitcher of *purpurea*, it is able to support itself on the surface film and wriggle its way to safety; and actual experience with *semicrocea* larvæ in *psittacina* has shown them capable of swimming from plant to plant. Both color and vestiture seem to have been modified, with an intelligible relation between these modifications and the characters of their food plants and the plant habitat.

The larvæ of all three species are strongly constricted between the segments; and two of the three species, *semicrocea* and *ridingsii*, beginning with their first larval molt, develop structures probably unique in this group of insects. These are greatly enlarged, spiny, lateral tubercles—"lappets," they have been called (see illustration p. 308)

What is the office of these "lappets," and why are they possessed by the two species, *ridingsii* and *semicrocea*, but not by the third, *rolandiana?* Undoubtedly they serve to keep their possessors from too intimate contact with the pitcher walls, the portion of the plant's insect trap against which these larvæ are in essential need of protection, for under like circumstances caterpillars of other species frequently become too tightly wedged in ever to escape, and these *Exyra* larvæ have the habit of penetrating to the lowest possible portions of their dangerous homes. It is still more significant that of the three, *rolandiana* only fails to develop these bristly "lappets" or "elbows," for this species, inhabiting the wide, squat pitchers of *purpurea*, has ample room between the walls, in that portion of the pitcher which it habitually occupies.

Whether the last larval food has been an unopened bud, a blossom, an immature, closed leaf, or an open pitcher, all three species of *Exyra* resort to a pitcher for pupation; and with the exception of the hibernated brood of *ridingsii*, for which open pitchers are often not available, they almost invariably select for this purpose a mature pitcher. *Rolandiana* spins a thin, flattened cocoon of pure white silk on the concave inner wall of the pitcher, well above the usual water level; or if the pitcher be a very small one, the cocoon may occupy the whole upper portion, a close, horizontal web serving to ceil the pitcher and to form the upper portion of the cocoon; or else, in an old leaf that contains no water, the cocoon may occupy the extreme bottom of the pitcher, often well hidden under an accumulation of insect remains, frass, and vegetable débris, in a small chamber partitioned off by the silken wall of the cocoon. If any reason for choice among these methods is discernible, it would seem that the first is more prevalent in large, roomy, well-developed pitchers, the latter in small, crowded, distorted, or mutilated ones.

Like *rolandiana*, *semicrocea*, preparing for pupation in any of its five food plants, usually enters a pitcher that has not been mutilated by feeding. A single, significant variation in *semicrocea's* pre-

Before spinning its cocoon of pure white silk (shown above) the larva of *rolandiana* usually crawls to a pitcher of *Sarracenia purpurea* that has not been mutilated by feeding and which shows no outward indication of the larva's presence

Before pupating the *semicrocea* larva closes the pitcher selected, often a considerable distance below the lips, with a ceiling web of denser and more opaque construction than that beneath which it has fed. Just under this web it constructs a filmy, silken cocoon. The tube is often slightly ceiled below the cocoon as well

paration for pupation as pictured above occurs in *psittacina*, whose pitcher has a concealed leaf orifice, small and tubular, hence offering greater difficulty for the escape of the emerging moth. In this plant the larva, before spinning the ceiling web or constructing its cocoon, cuts a large emergence hole in the peak of the hood; that is, *semicrocea* in its four food plants with wide-mouthed pitchers makes no provision for the escape of the moth, and in *psittacina* with its narrow orifice makes provision for that event.

In a mature leaf of *flava*, *ridingsii* preparing for pupation, resorts to entirely different methods: instead of changing to a new pitcher showing no external signs of its presence, it burrows down into the corky refuse of its own feeding, which fills the lower portions of the tube; in and of this material, with little or no apparent admixture of silk, it constructs an evenly rounded, oval cell in contact with the leaf wall on one side, within which it changes to a pupa. It does not ceil the pitcher above, with silk, for usually the top has already been eaten to a thin membrane and is in a more or less collapsed condition, which the larva frequently accentuates, as a preliminary to pupation, by girdling it above the frass level with a deeply cut, encircling groove, causing the whole upper portion of the pitcher to topple over and thus more effectually closing the tube. That is, the groove-cutting habit, employed by very young larvæ of *semicrocea* to produce a closed feeding chamber, and by *rolandiana* of like age for the same purpose, but of perhaps greater importance, to ensure a water-tight compartment for hibernation, reappears in *ridingsii*, a species otherwise barred from the use of this device by the seasonal history of its food plant, as a means of obtaining protection to the pupal chamber.

The hibernating larvæ of *ridingsii* are often ready for pupation before the pitchers of *flava* are open at the top, so that many larvæ of this brood are compelled to pupate in immature, unopened pitchers, and under these conditions they exhibit some habits not always apparent in the later broods. As a result of the larva's having entered and fed upon one of these pitchers, as already described, there has collected in the lower part of the tube a sufficient accumulation of corky frass in which to construct a cocoon. The collapsed and toppled-over upper portion effectually closes the tube above. Below the collapsed portion, but well up in the tube, the larva cuts an emergence hole, large enough for the moth, its wings still moist and flexible, to creep out; lower in the tube it cuts a much smaller hole to ensure drainage if in the pitcher's damaged condition rain water should gain access; just above the drainage hole it closes the tube with an open-meshed web, which permits water to drain through, but serves to exclude unwelcome insects from below; above the

drainage hole and below the emergence hole the larva then constructs its usual oval cell of corky frass and changes to a chrysalis.

The presence of these two holes is an infallible indication of the occupancy of the young pitcher of *flava* by the pupa of *ridingsii*. On the pitcher-plant meadows around Summerville, South Carolina, for example, in early May, hundreds of these pitchers may be thus identified, picked, and gathered, each containing a pupa ensconced between the two holes. These outward signs are recognized, too, by a bird—probably a partridge, but not positively identified—which splits the tube between the emergence and drainage holes and extracts the pupa. As was noted long ago by a botanical observer, the pitchers of *minor* are also habitually split open by birds for the insects contained therein; but *semicrocea*, the *Exyra* more frequently occupying these pitchers, by its habitual choice of unmutilated pitchers for pupation, avoids giving outward indication of its presence and is thus to some degree protected against this enemy. *Ridingsii*, constructing its cocoon from the refuse of its own feeding, is debarred from this defense.

Emergence of the moths usually takes place in the daytime. From closed pitchers the moths creep out while their wings are still moist and soft; in open pitchers they rest upon the inner wall of the leaf, above their cocoons, until ready for flight; and their first flight, in fact all their flights, seem to be simply from one pitcher to another. With no apparent structural adaptation by which to overcome the trap structures of the pitchers, their entrance and safe exit seem to depend simply on knowing how. In entering, they alight on the outside and run in over the rim; in leaving the pitcher, they climb the wall, half walking, half flying, and take flight from the rim or from the wide upper portion where there is room for the free operation of their wings. The pitchers are their habitual resting places. Here they sit on the inner walls, heads upward, backing farther down when alarmed or disturbed, flying immediately to another pitcher when driven out, and refusing to leave these shelters when the pitchers are plucked or even roughly handled and carried away. The moths of *Exyra* have been observed to feed upon the

The fact that the pitcher of *psittacina* has no adequate orifice through which the moth of *semicrocea* can escape when it emerges, makes it necessary for the larva before pupating to cut for the purpose a large hole in the peak of the hood

nectar secretion of the pitchers, but they do not seem ever to enter the flowers—in fact, *flava* and *purpurea* have practically ceased blooming before the *Exyra* associates of these plants, *ridingsii* and *rolandiana*, have reached the winged stage; so that these insects cannot be supposed to confer upon their plant

The larva of *ridingsii*, when about to pupate, constructs a cell in the corky refuse of its own feeding. When the cocoon is spun in mature pitchers, emergence and drainage holes, such as are shown in the companion picture, are often omitted.

The exterior of a young pitcher of *flava* with the two orifices made by *ridingsii*, the emergence hole through which the moth will later make its exit above, the drainage hole below. *Courtesy of Entomological News, XXIII, 1907*

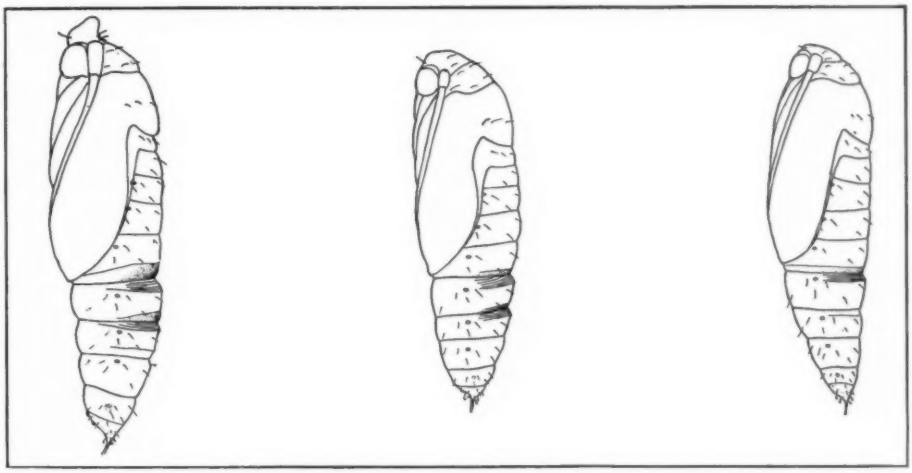
associates the return benefit of cross pollination.

The black and yellow colors of *semicrocea* and *ridingsii* and their conspicuous color patterns are probably ancestral, for this coloration seems to bear little if any relation to their association with the pitcher plants, and the very remarkable range of color variation exhibited by these insects does not seem to bear any imaginable relation to their plant habitat, though it may be a direct response to climatic and food-plant conditions. Hibernating larvæ of *ridingsii*, having an abundant supply of tender, juicy food, produce moths materially larger and much more heavily marked, even to the complete obliteration of the yellow areas of their wings, than those of the later broods feeding in dry, parchment-like pitchers in their sun-baked, midsummer condition. A similar range of variation in *semicrocea*, however, is *not* seasonal, and perhaps only the experimental production of these forms, if that be possible, will

satisfactorily determine their significance; in *semicrocea* there is, however, a direct food-plant effect on the *size* of the imago (the adult insect), probably resultant from the larval habit of refusing to change from pitcher to pitcher except under absolute compulsion through failure of the food supply; those from the small pitchers of *psittacina* and *rubra*, constantly average smaller than those from *minor* and *sledgei*, and these in turn, smaller than *drummondii*-bred moths.

ish purple tones of its food plant. The departure from the typical coloration of the genus occurs in the one species where this change is intelligible as an adjustment to its food-plant environment.

In a study of this kind there is abundant opportunity for a misinterpretation of some of the observed facts. When we endeavor to translate a document in an unknown cipher, we may easily be mistaken in the individual word; but when we spell out an intelligible and consistent



PUPÆ OF EXYRA

Ridingsii *Semicrocea* *Rolandiana*

The pupæ of the three species are very similar and present the usual noctuid characters, varying individually from pale amber to dark brown, almost black. Of the three species two, *rolandiana* and *semicrocea*, occupy filmy, silken cocoons; the third, *ridingsii*, a densely packed cell of corky frass. Of the three the pupa of *ridingsii* only has its front strongly and acutely produced over the head, the office of this pointed structure being to puncture the impacted wall of its cocoon

Rolandiana, too, exhibits a very wide range of variation, in part geographical, the southern examples usually being smaller and darker than the northern, thus giving rise, apparently, to the extreme form furnishing the types of Grote's *Exyra fax*. Of the three species *rolandiana* only, living in the one pitcher plant, *purpurea*, whose interior is not more or less concealed by an overhanging hood and whose wide pitchers are thus open to view from above, has acquired the purple-red, yellowish red, and black-

message, we have reasonable assurance of the correctness of our work. As we thus review the activities of *Exyra*, we find that some of the characters common to the three species are obviously related to their pitcher-plant environment, indicating a long continued and ancestral association with these plants; but more significantly, that many if not most of their specific differences, both of structure and instinct, are made up of adjustments or adaptations to their respective food plants. Is it not,

THE VARIABLE EXYRA MOTHS

The three species of the genus *Exyra* exhibit a wide range of variation—individual. seasonal, geographic. The two topmost rows are *ridingsii*, the three middle rows *semicrocea*, the two lowest *rolandiana*. *Rolandiana*, which in contrast to the other two species lives in exposed pitchers, is afforded partial concealment through its protective coloration

therefore, an inevitable conclusion that food-plant environment has determined the direction and course of their specific evolution?

If it is a "commonplace of evolutionary knowledge" that "among the best known illustrations of divergent evolution are the animals of oceanic islands, ... undoubtedly descended from common ancestors, yet having become distinct through changes which isolation prevented from being ground down to a common level by inter-crossing," then even the present distribution of *Sarracenia* gives further suggestion of the part of the food plant in the differentiation of *Exyra*. The geographical distribution of *Sarracenia purpurea*, from Labrador to the Gulf of Mexico, with no other plants of the genus occurring north of Virginia, places *rolandiana* out of contact with other *Exyra* for perhaps three fourths of its present extreme range. The plant is not generally distributed throughout this territory, but occurs in colonies often widely separated. *Exyra* in its winged stage—its only period of probable distribution—is short-lived, rather sluggish in habit, and weak of flight. These conditions, therefore, permanently separate a great majority of the colonies of *rolandiana* from direct contact with others of the genus and exhibit the conditions which would permit its origin in some food-plant "island" of *purpurea*, where group isolation would be as truly operative as in an oceanic island of the geographer; and of the three species only *rolandiana* exhibits a well marked geographical variation.

Although each species of *Exyra* is associated with certain *Sarracenia* species, usually to the exclusion of all others, any *Exyra* may be bred to maturity in any *Sarracenia;* and in the field, when pressed by failure of the food supply, any *Sarracenia* is recognized by any *Exyra* as a possible food plant. *Darlingtonia*, then, the only North American plant of the family with no *Exyra* associate, in its widely removed habitat suggests a food-plant "island" whose shores no *Exyra* has ever reached.

Food-plant "islands" may overlap or coincide geographically, and yet tend to separate their insect associates. At Summerville, South Carolina, where *ridingsii* is very abundant in *flava* and *semicrocea* in *minor*—these plants growing intermingled—*semicrocea*, hibernating as a last stage larva, finds its early spring food in the green, winter leaves of *minor*, and the moths appear in numbers about April 20; *ridingsii*, hibernating as an early stage larva in dry, dead leaves of *flava*, cannot complete its transformations until the spring growth of its food plant provides it with larval food. It does not leave its hibernaculum until about April 20, and the moths do not appear in numbers until May 20. Thus the spring broods of *semicrocea* and of *ridingsii*, in their mating stage, are separated by about four weeks—that is, the seasonal history of their respective food plants compels the partial isolation of one closely related species from another.

Even within the species we see something of this in process. In southern Mississippi, *semicrocea*, hibernating in *sledgei* as a last stage larva, completes its transformations and appears as a moth in early April. According to observations made in 1910, the spring emergence reached its height about April 10. In the same bog very young larvæ of this species, occupying their water-tight hibernacula in the pitchers of *psittacina*, were observed to awake from their winter lethargy in mid-April, and the first moth was noted in early May. Thus approximately a month intervenes between the appearances of moths of the same species from larvæ hibernating in the two food plants. When first found, especial attention was paid to these *psittacina*-feeding larvæ, for they were so different in age and habit from their fellows hibernating in *sledgei* that another species was confidently expected. The

following is a literal transcript of field notes made at the time:

"North side of Biloxi Bay, March 9, 1910. Opened 275 leaves of *psittacina*, gathered at random from plants growing in a very sloppy place, often partly under water or imbedded in wet sand; found three living *Exyra* larvæ, $\frac{1}{8}$ to $\frac{3}{8}$ inch long, in each instance the entrance to leaf strongly plugged by a water-tight partition, the larva low down in the narrow tube; several plugged leaves contained dead (drowned) larvæ."

As far as it is safe to judge by one season's observation, here seems to be in progress a selective process—a rigorous weeding out of all older larvæ, which had weakened their hibernacula by feeding, and of those which had not ceiled their pitchers exceptionally well—essential group-isolation enforced by food-plant characters, and a considerable degree of adjustment to those characters and to habitat.

We have tried to demonstrate, with reference to *Exyra* and *Sarracenia*, that the insects throughout their life cycle exhibit a remarkable degree of plasticity, of adaptability to varying conditions; that food-plant distribution, structure, and seasonal history, encourage or even compel group-isolation among the associated insects, creating conditions favorable to the preservation of divergent characters; that many, if not most, of the specific differences of the insects of this genus find their intelligible explanation as adjustments to food-plant characters; and since so large a proportion of these specific differences do consist of adjustments, specializations, to food-plant environment, how can we avoid the further conclusion, that on these food-plant "islands" there has been a selective process as well, by which advantageous divergences have been preserved to the exclusion of those of doubtful or of negative utility?

A growth of *Purpurea* near Tom's River, New Jersey

TOBACCO AS A CURE FOR AILMENTS

TODAY the use of tobacco is generally conceived of as a pleasant social indulgence, but among the Indians it was, and for that matter still is, smoked for a variety of specific purposes and for ends often contradictory or conflicting. It was used, for instance, to start a war as well as to cement a peace, to inflict bodily injury as well as to undo an injury inflicted, to appease spirits or to win their favor, in undertaking dangerous expeditions, in the ratification of treaties, in confirming sales, in the hunt, in agriculture, in placating the thunder, in petitioning the powers that guard the rain. The smoke of tobacco was a prayer wafted to the gods; a cigarette deposited in a shrine, or snuff sprinkled over the heads of idols, were gifts welcome to the beings that preside over men. In passing a shaman's grave in a canoe, a Tlingit Indian would lower four pieces of tobacco into the sea, saying "Give me luck. Do not let me perish. Do not let the wind blow so strongly on me." The Menomini placed tobacco before grave boxes and sprinkled it as well over rocks and stones of fantastic shape whose origin was attributed to Mä′näbŭsh, the great deity.

One of the more prevalent uses of tobacco was in the curing of disease or, to look at it from the angle of the Indian, in the expulsion from the body of the sick person of the malevolent being or thing responsible for his illness. It does not become us, however, to smile superciliously at this notion of the savage. When tobacco was introduced into Europe, it was widely regarded as curative, and centuries prior to its introduction smoking was prescribed as a medicament for various ailments by such physicians as Hippocrates, Galen, Avicenna, and others. Notwithstanding the relentless war waged on tobacco in the seventeenth century, the belief was by no means uncommon that those in the habit of using tobacco were exempt from disease. It is in conformity with this idea that Pepys, writing under date of June 7, 1665, when the great plague was raging, makes this entry in his diary: "This day, much against my will, I did, in Drury Lane, see two or three houses marked with a red cross upon the doors, and 'Lord have mercy upon us!' writ there; which was a sad sight to me, being the first of the kind that, to my remembrance, I ever saw. It put me in an ill conception of myself and my smell, so that I was forced to buy some roll-tobacco, to smell to, and chaw, which took away my apprehension."

Writing some two decades prior to Pepys, Lord Herbert of Cherbury—

> All-virtuous Herbert! on whose every part
> Truth might spend all her voice, fame all her art!

laments the pollution of his breath by tobacco, "which toward my latter time I was forced to take against certain rheums and catarrhs that trouble me, which yet did not taint my breath for any long time." Even Robert Burton, who, resorting to the extravagances of invective, condemned tobacco taken for pleasure as "a plague, a mischief, a violent purger of goods, lands, health, hellish, devilish, and damned tobacco, the ruin and overthrow of body and soul," strange to say, believed in the medical properties of the "weed."

During the years 1887–88 Mr. James Mooney obtained for the United States Bureau of Ethnology about six hundred sacred formulas set down by the shamans of the Cherokee. The manuscripts are written in the characters invented or rather adapted in 1821 by Sikwâ′ya (Sequoyah), a member of the tribe. These characters were derived from the Roman alphabet but as their adapter did not know the sounds associated with the letters in English, he assigned to them different values in Cherokee, and in addition altered their form to suit his purposes. He devised also about forty new characters.

In not a few of these sacred formulas

the use of tobacco is prescribed. One of the alternate remedies suggested for the ailment quaintly described as "pains moving about in the teeth" consisted of the blowing of tobacco smoke from a pipe placed directly against the tooth or teeth affected. The practitioner treating those who were "painfully sick" retained in his mouth the blossoms of three plants, one of which was *Nicotiana rustica*, or more likely a decoction made of the three. Upon withdrawing his mouth from the afflicted part and ejecting the fluid it contained, there would be found in the fluid, if the credulity of the patient was sufficiently strong or the dexterity of the practitioner sufficiently great, some minute object—pebble, insect, or stick—which the practitioner would point to as the cause of the trouble.

Tobacco was the plant commonly employed to undo or to combat witchcraft. One of the sacred formulas is entitled "to shorten a night-goer on this side." A night-goer was another name for a witch, the Cherokee believing that witches prowl about the dwellings of sick people after nightfall, malignly awaiting the opportunity to slip in and "shorten the occupants on this side" or, in other words, to kill them. The advantage that accrued to the witches was the lengthening of their own span of life through the premature termination of the alloted span of their victims. With the object of beating the evil spirits at their own game the shaman just before dark issued from the forest. Walking deliberately about the dwelling that was threatened, he blew smoke from his pipe toward every trail along which the night-goer might make an approach. Thus the patient was saved.

When a Cherokee was bitten by a snake, a formula prescribed that the shaman should make light of the antagonistic spirit by referring to it disdainfully as a mere frog. In addition, he was required to rub tobacco juice on the wound (which must have been soothing to the victim) or in the absence of tobacco juice, he was to apply saliva. During the process of rubbing he had to walk in a circle about the patient from right to left four times, thereby uncoiling the snake, which makes its circles from left to right. Among the Zuñi smoke from a corn-husk cigarette containing native tobacco was blown over the body of anyone suffering from rattlesnake bite as a supplement to the local treatment applied.

The Pima used cigarette smoke to diagnose the nature of an illness, claiming that he could discern the disease through the fumes. This people entertained the curious belief that when a horse was taken sick, it was because some ill-disposed person had shot a burning coal into its body. The point of entry was located through the medium of smoke. The individual trying to effect the cure would pretend to extract the hot coal by applying his mouth to the afflicted animal, meantime making grimaces that convinced the bystanders that he was indeed being burned. He would then fill his mouth with water and spew out the coal.

In the strangely interesting ceremony practised by the Navajo for the recovery of the sick, it was customary for the invalid, repeating the prayer of the theurgist, to offer to the people of the mountain and rocks and to earth itself cigarettes or tubes containing little balls made of the down of humming birds, corn pollen, and tobacco, lighted through a crystal by the rays of the sun. Live coals were placed before the invalid and over them was sprinkled tobacco so that he might be restored through inhaling the fumes. Even the masks of the impersonators of the gods received in the course of this therapeutic ceremony puffed offerings of tobacco smoke.

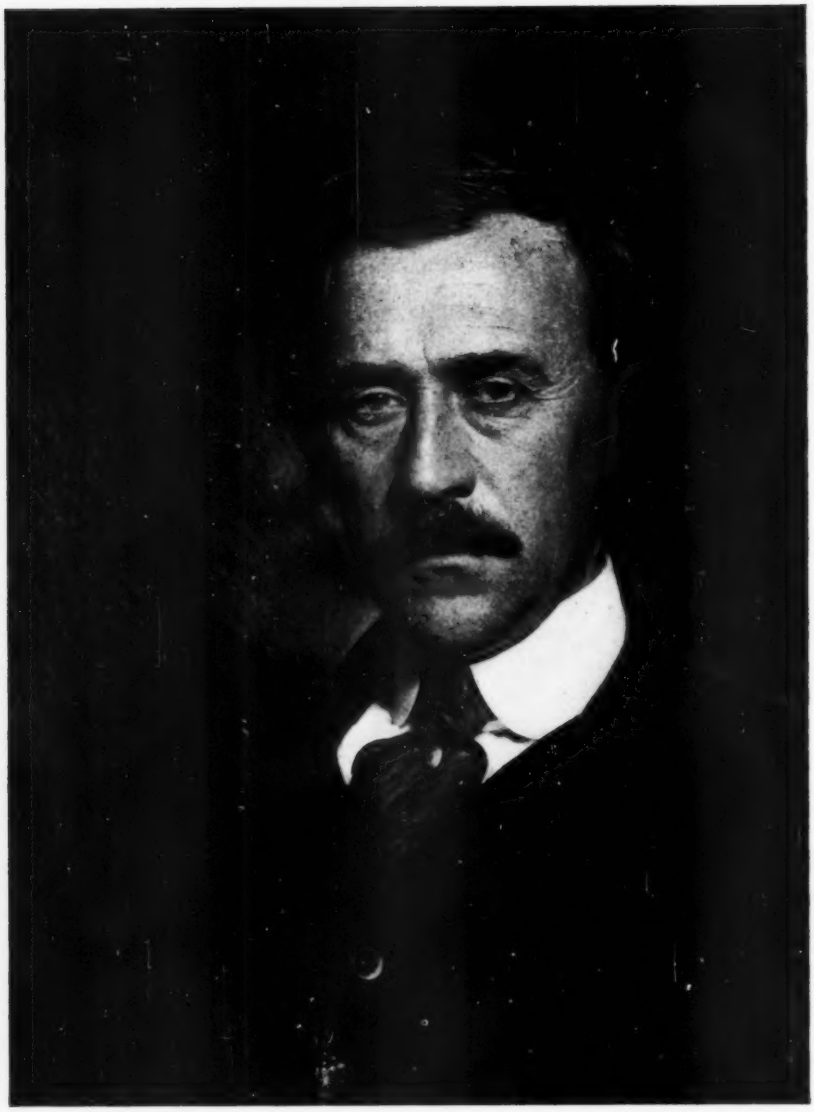
The Navajo have a tradition that at one time a young man of their tribe fleeing from Utes entered a cave where there was a fire issuing from four stones colored respectively black, blue, yellow,

and white. Near each stone was a bear colored to correspond. The bears demanded tobacco and though at first claiming that he had none, the Navajo at last yielded to their angry insistence. Filling a pipe with tobacco he had taken from the Utes, he handed it to the black bear, who, taking one whiff, just managed to pass it to the blue bear before dropping insensible. The blue bear ventured to puff twice; then, passing the pipe to the yellow bear, he too succumbed. The yellow bear was rendered insensible with the third puff, the white bear yielded to the fourth. Then the Navajo took his pipe and rubbing with it the bodies of the inert animals speedily resuscitated them.

A Cherokee hunter who, having failed properly to prepare himself by fasting, collapsed when taken to view a city located in the center of a mountain, was restored to strength by having his legs rubbed with tobacco and his nostrils stimulated by its fragrance.

Yet be it said that although in the above mentioned instances tobacco was looked upon as curative, its effects were sometimes disastrous or nearly so; witness the following curious test required of the Indian who in Guiana aspired to be a *piai*. To attain this dignity required prodigious fortitude in addition to a strong constitution. The novitiate had to undergo the agonies of thirst and of hunger and tortures of the flesh without protest or complaint. In some localities his skin was slit, in others mats or belts swarming with biting ants were attached to different parts of his body. The green leaves of tobacco were pressed until they had yielded their juices, and this decoction the novitiate was compelled to swallow at intervals during the period of preparation. The great tobacco ordeal occurred, however, on the day of his installation. An eyewitness has recorded that on one such occasion he saw the novitiate swallow "a calabash containing about two pints of tobacco juice." The same observer states that most frequently the novitiate "falls into a swoon, whereupon he is carried to his hammock: if he does not vomit directly after taking this powerful emetic he dies, or at least he is seized with horrible convulsion and breaks out into cold sweats, etc., which all tend to bring him to the grave. But if he survives, he is acclaimed *piai*."

We have noted some of the potencies ascribed to tobacco in the New World; in the Old it was credited similarly with curative powers and because of this was referred to by Spenser in his *Faerie Queen* as "divine tobacco," by the Spaniards as "*santa yerba*," the holy herb, and by the French among other designations as *herbe propre à tous maux*, or remedy for all ailments.—H. F. S.



MR. WALTER GRANGER

Unusually keen in the discovery of minute and inconspicuous forms, and no less expert as a stratigraphic geologist, Mr. Granger is eminently qualified for his coming palæontological field work in Asia

MR. WALTER GRANGER AND THE THIRD ASIATIC EXPEDITION

MR. WALTER GRANGER left the American Museum on May 14 to join the Third Asiatic Expedition, now established in Peking. He is peculiarly well qualified, by nature and training, for the reconnaissance and exploration work among the extinct mammals of eastern Asia. At the age of seventeen, a typical Vermonter, tall, fair-haired, blue-eyed, he entered the Museum service in the department of taxidermy under Jenness Richardson, who also came from Vermont. He commenced work in October, 1890, at the slender salary of twenty dollars per month. In 1894 he took his first western trip to collect mammals for Doctor Allen's department, especially in the region of the Big Bad Lands of South Dakota, which were then being explored by American Museum palæontological parties. The following year he went into the Uinta and Washakie regions of southwest Wyoming, giving half his time to mammalogy and half to vertebrate palæontology, under the able training of Dr. J. L. Wortman. In 1896 he joined the staff of the department of vertebrate palæontology and has since been in charge of the Eocene division, undertaking in successive seasons, no less than twenty trips altogether to the Rocky Mountain region, which have resulted in making the American Museum the richest depository in the world of the life of Eocene times. In 1907 he accompanied Professor Henry Fairfield Osborn on a journey to the Fayûm region of Egypt to hunt for the ancestors of the Proboscidea and, with the aid of Mr. George Olsen, secured a collection which has since proved to be superb. On this expedition many of the small types of animals were discovered that had escaped the eyes of British explorers.

In the intervals between the Rocky Mountain work Mr. Granger has been associated with Curator Matthew in describing the Eocene life of North America, especially devoting himself to the ancestral horses and other small ungulates. When hunting fossils in the field his eye is like that of a hawk in detecting in the distance small and nearly invisible objects. Thus has he become a master in the search for microfauna which have escaped the less vigilant vision of earlier explorers. A catalog of the minute forms of primates, insectivora, and rodents which he has found will fill many pages of fine text. He has become no less expert as a stratigraphic geologist and with Professor Osborn and Doctor Matthew has greatly contributed to the knowledge of the Eocene and Oligocene of the Rocky Mountain region, from which the division of this region into sixteen distinct life zones, each with sharply defined fauna, has been made. On arriving in China Mr. Granger's first duty will be to get in touch with the Geological Survey of China,[1] with its Director, Dr. V. K. Ting, and with Mr. J. G. Andersson, mining adviser to the Chinese Government and curator of the Museum of the Geological Survey of China, who have kindly offered to conduct Mr. Granger over some of the fossil beds already discovered and worked by the Survey of China. In another season Mr. Granger hopes to accompany Chief Roy Chapman Andrews on an expedition into the unknown fossil regions of the north.

Meanwhile the Museum enjoys the hospitality of the Geological Survey of China and is working in fullest accord with Director Ting and Mr. Andersson. It is distinctly understood that the work of the American Museum is of coöperative character, such as is carried on by many private institutions of this country in coöperation with our own U. S. Geological Survey.

[1] See NATURAL HISTORY, January-February, 1921, p. 1.

NOTES

Since the last issue of NATURAL HISTORY the following persons have been elected members of the American Museum:

Life Members: MESDAMES JOHN W. T. NICHOLS, A. A. ZUCKER; MESSRS. JOHN S. PHIPPS, HENRY C. QUINBY, AND WARREN THORPE.

Annual Members: MESDAMES EDWARD DEAN ADAMS, FINLEY PETER DUNNE, WINTHROP DWIGHT, ERNESTO G. FABBRI, C. LAGEMANN; THE MISSES SYBIL KENT KANE, VELMA L. LILLIE, K. T. MOORE, DOROTHY OAK, R. SEED; CAPTAIN CHARLES W. HALSEY; DOCTORS DAVID B. FREUNDLICH, DE WITT STETTEN; MESSRS. CLIFFORD W. ASHLEY, THEODORE H. COOPER, PAUL R. FREISINGER, EDWIN F. GAY, B. B. GIRDEN, EDWARD O. A. GLOKNER, EDWIN L. MEYERS, GEORGE J. OPENHYM, CORNELIUS POILLON, THEODORE PRINCE, EDWIN A. SEASONGOOD, WILLIAM E. TAYLOR, C. H. TUCK, CHARLES ELLIOT WARREN, AND LEWIS BLAIR WILLIAMS.

Associate Members: MESDAMES LEONARD AHL, H. A. AINSWORTH, HORATIO C. ALLEN, E. F. ATKINS, MARY S. AVERY, C. H. BABCOCK, CHARLES BAILEY, A. D. BALDWIN, HANNA E. BELDEN, EMMA BLANCHARD, CHARLES E. BLUE, GIDEON BOERICKE, ELLEN L. BORDEN, LIDIAN E. BRIDGE, CLIFFORD BRIGHAM; THE MISSES AGNES A. ACTON, ORPHA LORENA APP, CAROLINE F. BARR, LUCY B. BLISS, JANE E. BREWSTER, LYDIA M. LABOITEAUX, ANNE MANGOLD, MARGARET JANE SCHMIDT; HIS EXCELLENCY BORIS A. BAKHMETEFF; THE HON. JOB BARNARD; DOCTORS CHARLES MINOR BLACKFORD 2D, RAYMOND C. MOORE, R. A. NEWMAN, ELMER G. PETERSON, H. L. RUSSELL, CHARLES C. STILLMAN, H. GIDEON WELLS, GARDNER F. WILLIAMS; MESSRS. JOSEPH ADAMS, W. L. ALEXANDER, H. W. ALTHOUSE, GEORGE B. ALVORD, CHARLES L. AMOS, EDWIN C. ANDERSON, EDW. E. ARMSTRONG, CLARENCE M. ARNOLD, GEORGE C. ATWELL, GEORGE L. BAKER, J. M. BALDRIGE, ROBERT F. BALDWIN, HENRY C. BALLOU, WILDER D. BANCROFT, ROBERT BATCHELLER, Q. E. BECKWITH, HENRY BENEKE, COGSWELL BENTLEY, C. HERBERT BENTON, JACOB BERGES, GEORGE H. BISSINGER, O. S. BLANCHARD, ELMER F. BOTSFORD, JAMES P. BOYD, F. BRADSHAW, J. WARNER EDWARDS, C. M. HOLMES, EDWIN LINCOLN MOSELEY, ALBERT E. NOBLE, R. A. PORTER, CHARLES P. PRICE, ROY H. SMITH, EMORY W. THURSTON, A. C. WASHBURNE, AND E. R. WOLCOTT.

PRESIDENT HENRY FAIRFIELD OSBORN of the American Museum is spending a few weeks in Europe. One of the purposes of his sojourn is to complete certain chapters on Neolithic man which will find place in an enlarged edition of his *Men of the Old Stone Age*. From England Professor Osborn will go to Scandinavia and later to other countries of the Continent, coming into touch with scientific circles in all of the places visited.

FOR some months past Associate Curator N. C. Nelson of the department of anthropology, American Museum, has been working over an archæological collection from Egypt, northwest Africa, and Spain. As the Egyptian specimens are not accompanied by chronological data, their date must be inferred either by comparing them with the record from western Europe or by studying their surface appearance. Those that have been exposed for a long time have undergone a greater degree of patination than those exposed more recently and in this way the relative age is revealed. The artifacts from Egypt were found on the surface of the desert, while some from northeast Africa and Spain were found in caves. Remarkable as it may seem, there is some agreement between the desert specimens and those obtained from the caves.

DR. Y. B. TSAI, chancellor of the National University of Peking, China, was the guest of the president and the Board of Trustees of the American Museum on Monday afternoon, June 6. Chinese officials in New York and Washington and the Chinese students of the vicinity were invited to meet the chancellor at tea in the Age of Man hall. President Osborn received Dr. Tsai and his party in the members' room. Dr. Tsai was pleased with the organization of the Museum, its relation to the city, the character of its research and exploration, and its service in educating the public. The Chinese guests were escorted by Director Lucas and other members of the staff through the exhibition halls and were keenly interested in the methods of exhibition used and particularly in the work connected with the schools. The chancellor also expressed his hope for the success of the work which the Third Asiatic Expedition is undertaking in China under the leadership of Roy Chapman Andrews.

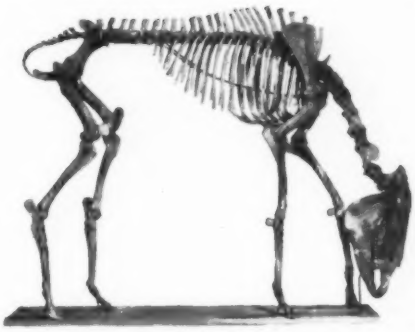
IN order to bring the assistance which the American Museum of Natural History offers to teachers, directly to the attention of a large number of young women who will enter upon their work in the New York schools for the first time this fall, a reception was held at the Museum on May 23 for the graduating class of the Maxwell Training School for Teachers. The seniors from the New York Training School were entertained in a similar manner on June 9. On both occasions, President Henry Fairfield Osborn welcomed the guests, speaking of the debt society owes to teachers and of the desire

of the American Museum to coöperate with the city's department of public education. Mr. George H. Sherwood, curator of public education, surveyed briefly the activities of the American Museum in the service of the schools. He illustrated with stereoptican views such representative features of the department as the circulating collections, the work with the blind classes, and the docent service. He also gave a demonstration how lantern slide material may be used in the teaching of geography. This was further illustrated with a motion picture of the formation and eruption of volcanoes explained by Dr. G. Clyde Fisher.

At the second reception, the Museum was honored by the presence of Superintendent William L. Ettinger, who expressed the appreciation of the superintendents and teachers for the service the Museum is rendering the schools, and urged upon the graduates the desirability of utilizing in their profession the extensive facilities which the American Museum and similar institutions have to offer. At the close of the hour in the auditorium, members of the staff escorted the teachers through the exhibition halls and especially through the offices of the department of public education, where samples of the various loan collections, including health charts and food exhibits, of the material used in classes for the blind, and of collections circulated in schools and libraries, were displayed. Dr. Hugo Newman, principal of the New York Training School, who was present with other members of the faculty, expressed satisfaction with the educational work of the Museum and his willingness to coöperate with members of the staff in order that their loan material might meet even more completely the needs imposed by the curricula of New York schools. Tea was served in the hall of the Age of Man.

COLLECTIONS of Alaskan butterflies and fishes will be obtained for the American Museum by Mr. Robert Anderson Pope, a landscape architect and town planner interested in natural history, who left in July for high altitudes in the interior of Alaska back of Anchorage, to be gone until September. Mr. Pope called at the Museum just before leaving New York.

THE horse is so closely associated with man that we are apt to forget that his family tree is vastly more ancient than that of the proudest of the human race. While few of us know our forbears beyond a few generations, the horse, thanks to the data supplied by fossil remains, has a named and described ancestry extending back to the dawn of the Tertiary. Visitors to the American Museum are able through the progressive series of specimens on exhibition to visualize the gradual evolution of the horse from a small, four-toed creature in the Eocene to the one-toed, powerful animal that we know today. A gap in the exhibition series was recently filled through the addition of a superb, mounted specimen of *Pliohippus*. This animal represents the earliest stage of the one-toed horses. It is intermediate between the three-toed horses of the Miocene and the one-toed horses (*Equus*) of the Pleistocene. *Pliohippus* is realistically mounted, with lowered head as though browsing. The specimen was secured from the Snake Creek locality of Nebraska, where a systematic search will be conducted this summer for additional material.



This skeleton, *Pliohippus*—an important recent addition to the American Museum's exhibit illustrating the evolution of the horse—represents the earliest stage of the one-toed horses

ANOTHER skeleton which has recently left the laboratory to take its position among the palæontological exhibits on the fourth floor of the American Museum is *Trilophodon productus*, one of the long-jawed mastodons, which inhabited the Old World and North America during the Miocene and Pliocene epochs, a few surviving until the Pleistocene. The long-jawed mastodons have the front of the lower jaw extended in a long, spout-shaped process, on which the trunk rests instead of hanging free as it does in elephants. The skeleton is that of a single individual. Thirteen vertebræ, the ribs, the pelvis and sacrum, the left hind limb bones and the heel and ankle bones of the left hind foot are original bone; the missing parts are restored in plaster. In a wall case near by are exhibited the original skull and jaws.

AMONG the creatures of the past that because of their great size seem rather to have stepped out of some fairy tale than to hold a place in the world of actual things are the great extinct birds, such as the *Moa*, *Æpyornis*, and *Diatryma*. The last mentioned has just been added to the exhibits on the fourth floor of the American Museum. This bird, a contemporary of the

One of the great extinct, flightless birds, *Diatryma steini*, recently placed on exhibition at the American Museum

little *Eohippus*, or four-toed horse of the Eocene, was bulkier than any ostrich. It had an enormous head and a high, compressed beak unlike that of any living bird. Its wings were so reduced that it was incapable of flight. Remains of this bird are exceedingly rare and until this skeleton was found, it was known only from a few fragments of foot bones found in Wyoming, New Mexico, and New Jersey.

NOTABLE additions to the dinosaur exhibits have been made or are in contemplation. The mount of the running dinosaur *Gorgosaurus*, an impressive representative of these great reptiles of the past, was placed on view some months ago. In August a skeleton in standing pose of the ostrich-like dinosaur *Struthiomimus* will be exhibited. Next winter skeletons of the horned dinosaurs *Triceratops* and *Monoclonius* will be ready.

DR. FRANK M. CHAPMAN, curator of the department of birds, returned from England June 22 after a sojourn of one month in that country. His time was devoted primarily to a study in the British Museum of the collections of birds from Ecuador in connection with the preparation of a *Bulletin* on the distribution of birds in that country similar in character to the one already published on the birds of Colombia (*Bull.* XXXVI, Am. Mus. Nat. Hist.). Most advantageous exchanges were also made with the British Museum and with the museums at Tring and Cambridge, resulting in the acquisition of 136 species new to the South American collections of the American Museum and including numbers of co-types and authentic specimens.

During his stay in London Dr. Chapman delivered illustrated addresses on the Museum's explorations in South America before the Zoölogical Society and the British Ornithologists' Club.

A GROUP of distinguished visitors from Sweden, on their return to Stockholm after several months of travel in Argentina, Chile, and Brazil, were welcomed on May 28 to the American Museum of Natural History by President Henry Fairfield Osborn. Mr. Knut Wallenberg, formerly Minister of Foreign Affairs and head of Stockholm's Enskilda Bank, responded to the president's welcome. Director Lucas and other members of the staff conducted the visitors, who were particularly interested in observing educational methods and in visiting to this end educational institutions in this city, through the exhibition halls. The distribution of small, circulating collections among the public schools for use in nature-study classes was a feature of the Museum's work which received especially favorable comment. Mr. Wallenberg was accompanied by his wife, Dr. and Mrs. Johannes Hellner, Mrs. Hellner's sister (Miss Berge), Consul General and Mrs. Joseph Sachs, and Dr. Naukhoff. Dr. Hellner was also a former Minister of Foreign Affairs and is now a judge of the Supreme Court. Consul General Sachs acted as a member of the Swedish War Trade Commission and is president of Nordiska Kompaniet. The party also visited in Washington, D. C., where they were entertained by Mr. Wallenberg's brother, the Swedish Minister to the United States.

ONE of the most impressive exhibits recently installed on the fourth floor of the American Museum is the rectangular block from the Agate Quarry of Nebraska, consisting of a closely packed jumble of fossilized bones and no less than twenty-two skulls of *Diceratherium*, an early rhinoceros. The visitor to the American Museum is so accustomed to seeing the finished mounted specimen on which under scientific guidance has been lavished the care of the preparation department that it is instructive to glimpse the condition of the skeletons when first removed from the earth. The mass containing these skeletal remains weighed at the time of its arrival at the Museum nearly three tons. The resourcefulness of the department of preparation is frequently put to the test. Housewives will be interested to learn that though the usual tools were of service, the most effective appliance in giving the block its present immaculate appearance was a vacuum cleaner, special tubes being fitted into the depressions of the irregular surface of the block to draw forth the dirt therein.

To clean a block of such uneven surface as that shown in the illustration below, required no little resourcefulness on the part of the preparation department of the American Museum, to whose skill it was entrusted upon being transported from Nebraska. A vacuum cleaner, fitted with special tubes to penetrate the cavities and extract dirt, proved very helpful

This chaotic jumble of bones, the skeletal remains of extinct animals, shows how plentifully fossil beds sometimes reward the search of the palæontologist. The assemblage is not artificial but represents a condition of crowding actually encountered. This block from the Agate Quarry of Nebraska is on exhibition on the fourth floor of the American Museum

PROF. C. P. BERKEY, of Columbia University, is preparing to join the American Museum's Third Asiatic Expedition, in the spring of 1922, as chief geologist. He has secured a leave of six months from his university duties for the purpose and is fitting himself for this reconnaissance work by studying all the geologic treatises on China, Mongolia, and Tibet. Through correspondence he will keep track of Mr. Walter Granger's preliminary work in palæontology (see p. 321 of this issue), so that by the time he reaches the field, the palæontologist and geologist may be ready to begin their expedition to the north without delay.

MR. CLIFFORD H. POPE, a member of the Third Asiatic Expedition, will soon join Chief Roy Chapman Andrews in China. Mr. Pope is especially interested in the study of reptiles and fishes and expects to devote attention to these as his share of the work of the expedition. Mr. Pope studied for two years at the University of his native state, Georgia, and completed his course at the University of Virginia, where he was graduated in May, 1921, with the degree of bachelor in biology. He is particularly well prepared for the field work he is undertaking in connection with the present expedition by a summer of practical experience and observation in the Bronx Zoölogical Park, where he gave especial attention to the occupants of the reptile house, as well as by his studies of fish habits made during the summers of 1919 and 1920, under Mr. William Beebe, at the New York Zoölogical Society's Tropical Research Station, Katabo Point, British Guiana. Both Mr. Beebe and Mr. Raymond L. Ditmars, under whose direction he worked at the Zoölogical Park, highly commend Mr. Pope for his energy, sincerity of purpose, and scientific ability. Mr. Pope sailed from San Francisco on May 31 with Mr. Walter L. Granger.

A MAP of Ecuador has proved essential to the publication of the biological work of the American Museum in the Andean region and is now being prepared under the direction of Curators H. E. Anthony and Frank M. Chapman by Mr. Briesemeister, one of the staff of the American Geographical Society. When completed, it will be the best map of Ecuador extant, for it will embody the results of the latest surveys by the French and the observations of the American Museum's expeditions and of those of other institutions. Curator Anthony is at present working on the British Guiana mammals collected for the Museum by the Tropical Research Station under Director Beebe. When this is completed, he will begin at once to describe the fine collections which the Museum has recently obtained from Ecuador. His observations on the mammals will be a complement to those which Curator Chapman will embody in his volume on the birds of Ecuador and northern Peru.

DR. WILLIAM K. GREGORY, curator of comparative anatomy, American Museum, is spending the summer in Australia. He is visiting the scientific institutions and coming into personal touch with the scientists of that continent. It is hoped that exchanges of specimens between the American Museum and its sister institutions in Australia can be arranged. Exhibition material so acquired will ultimately find place in the contemplated Australian hall. So great has been the destruction of Australia's interesting animals, owing to the demands of the fur trade, that many are approaching extinction. Dr. Gregory hopes to bring back with him a representative collection of this vanishing fauna. Cordial assistance with a view to facilitating his work has been promised Dr. Gregory by officials at Sydney, Melbourne, and Adelaide. Through the friendly interest of Mr. C. Anderson, director of the Australian Museum at Sydney, the services of an experienced collector and bushman have been secured, who will aid Dr. Gregory in his field work. Mr. Edgar R. Waite, director of the Public Library, Museum, and Art Gallery of South Australia, has given assurance that the Board of that institution will do all it can to facilitate Dr. Gregory's work. Travel through the land will be easier as a result of the kind efforts made with this object in view by Mr. D. Le Souëf, director of the Zoölogical Gardens, Melbourne.

WORK has been begun upon the reshaping of the Morgan hall of minerals in the American Museum in accordance with a plan which had its inception over two years ago. The carrying out of this project has been rendered possible through the generosity of Mr. George F. Baker.

By this arrangement not only will the lighting and architectural attractiveness of the hall be much improved, but enough space will be gained to enable the Morgan collection of gems to be installed in closer relation to the minerals, thus securing better correlation between these two collections and better lighting for the gems. The reinstallation of both collections involves the use of a number of new cases and will necessitate the closing of the mineral hall for several months.

MR. HERBERT P. WHITLOCK, curator of mineralogy, American Museum, is conducting a course on gems and precious stones at the summer session of Columbia University. The object of the course is to create an intelligent and discriminating interest in gems and precious stones and to lay the foundations for a better appreciation of the splendid collections of this kind in New York City.

The first lecture was devoted to diamonds and

methods of polishing them, a subject discussed by Mr. Whitlock in the present issue of NATURAL HISTORY (p. 291). The course consists of six lectures and in connection with it there are being used for purposes of illustration colored lantern slides prepared from photographs of specimens in the Morgan hall of gems. Also a series of informal conferences are being held on Mondays at the American Museum. The students meet in the gem hall and have an opportunity to inspect the material referred to in the lecture of the previous day and to ask questions regarding points on which they desire fuller knowledge.

The collection in the American Museum includes practically every known variety of cut stone, in addition to raw gem material of great interest. Some of the examples of precious and semiprecious stones cannot be duplicated anywhere.

THROUGH the generosity of several friends, the newly organized department of entomology at the American Museum has secured a camping automobile for use in field work. This year an intensive study is being made of the pine barrens of New Jersey, the nearest approach to a desert that we have in this region. The department plans to use the car next year for a continuation in Utah and Arizona of the studies concerning geographic distribution that were begun when entomology was included in the department of invertebrate zoölogy, and which have involved field work in Labrador, Florida, a number of the islands of the Caribbean, British Guiana, Arizona, Colorado, Idaho, Wyoming, and other scattered parts of the West.

DR. D. VAN HOVE, Chief Inspector of the Phytopathological Service in Belgium, and Professor Pynaert of the Horticultural School at Ghent, visited the American Museum in May. Dr. Van Hove, whose business it is to prevent the shipment of any diseased plants to the United States, is interested in entomology as well as in horticulture. Dr. Van Hove and Professor Pynaert, who in the brief time at their disposal were conducted through the entomological exhibits by Dr. Joseph Bequaert, pronounced these exhibits the finest they had seen. Recent revision of the laws pertaining to the importation of plants to America is the immediate occasion for Dr. Van Hove's visit to the United States.

IT IS a somewhat singular fact that the Adirondacks, situated in the most populous state of the Union and today an irresistible attraction to thousands, remained for some two hundred years after their discovery by Samuel de Champlain virtually unpenetrated by the white man. The Indian, too, used the region sparingly as a place of sojourn, the existence of only one Indian settlement, and that a temporary one, being definitely known. Pike's Peak in the inaccessible West was ascended by members of Major Long's party nearly two decades before Mount Marcy, the loftiest mountain not merely of the Adirondacks but of all New York State, was scaled. It was actually not until 1872 that Lake Tear-of-the-Clouds, the highest pond-source of the Hudson River, was discovered, secluded in the Adirondacks.

In like manner there has been tardy recognition of the region in literature. While other sections less attractive and interesting have been written up exhaustively, no adequate history of New York State's great natural park had appeared prior to the publication this spring, under the imprint of the Century Company, of *A History of the Adirondacks* by Alfred L. Donaldson. If there has been delay, however, in giving the region its due, it is justified by the final accomplishment, for Mr. Donaldson has written a two volume work that is not merely painstaking and veracious but that has the rarer quality of charm. He has gathered together not only by research through written records but by personal contact and correspondence with those who could shed light, a vast number of interesting facts regarding the early times, the nearer past, and the present. It is in the racy portraiture of those whose lives have been associated with the region that the author particularly excels. Little vignettes like the following of "Old Mountain Phelps," who had ascended Marcy more than one hundred times, abound:

"He was prone to nickname the natural wonders that he loved best. Mount Marcy he always called 'Mercy.' He held it to be the stateliest peak, commanding the finest view in the world. People would sometimes speak of the Alps or the Himalayas as having mountainous merit. But such idle talk annoyed him, and he would squelch it with a sneer. 'I callerlate you hain't never been atop o' Mercy,' he would say, and turn away in disgust. His own joy in standing there he expressed as a feeling of 'heaven up-h'isted-ness.'"

There are graphic chapters on John Brown and the escaped slave settlement in the Adirondacks with which he was associated, on Dr. Trudeau, on Robert Louis Stevenson's sojourn in the region, on Harry Radford, champion of the local wild life and the restoration of the moose, and a host of other characters, in addition to the sketching of events belonging to the history of the region and incidental attention to the scenic attractions.

THE Redwoods Preservation Bill, recently passed by the legislature of California and signed by Governor Stephens of that state, will redound to the advantage not only of the people of the Pacific coast, the principal beneficiaries,

but to the citizenry of the whole country, who in increasing numbers are visiting the scenic attractions of the land. Under the terms of the Act, the sum of $300,000 is to be expended for the purchase of stands of the *Sequoia sempervirens* in Humboldt and Mendocino counties, California, for the enjoyment of those who travel along the state highway. It is to be hoped that the enactment of this protective legislation may be but the prelude to securing a federal appropriation for the creation of a great National Redwoods Park. Through the sum at present set apart, the trees most immediately menaced have been saved but double the sum will be required to preserve all the redwoods necessary to maintain the scenic beauty of this highway. The credit for saving from the axe what is not only one of the most beautiful but, on account of its vast age, also one of the most interesting of trees, belongs in no small measure to the Save the Redwoods League of Berkeley, California, which owes its inception to the public-spirited efforts of President Henry Fairfield Osborn, of the American Museum, and to Mr. Madison Grant, of the Board of Trustees of that institution.

On the evening of June 13, the Zoölogical Society of St. Louis celebrated a "zoo night," one of the features of which was the dedication of a fine bear habitat. This society has just completed arrangements for taking 5833 children from the congested district of St. Louis to enjoy a day's outing in its Zoölogical Park.

In connection with the article by Dr. Connor on "Fish as Mosquito Destroyers" (p. 279 of this issue) attention may be called to the fact that, with a view to combating the malaria mosquito, Spain has imported from our state of Georgia, the minnow, *Gambusia affinis*. It is this fish which was used so successfully by Dr. H. H. Howard in Hines County, Mississippi. It is reported that the minnow is adapting itself to its new environment.

As long ago as 1870 Richard Owen described two species of an ancient type of elephant from China, one of which, *Stegodon sinensis*, is said to be found near Shanghai; the other, *Stegodon orientalis*, in the province of Szechuan. In 1885, a still more ancient type of elephant, named *Mastodon sinensis*, was described from Yunnan by Ernst Koken, as part of the large collection obtained by the great explorer Richthofen. Yunnan, which is very rich in ancient mammal life closely similar to that found in the Siwalik Hills of northwestern India, will probably be explored by members of the Third Asiatic Expedition of the American Museum. Of thirty-five kinds of animals described by Koken, twenty-eight are from Yunnan, which is the most westerly province of China, bordering Burma.

In a recent review of the ancient life of China and Japan by Matsumoto and Joleaud, it is pointed out that the third great contributor to the knowledge of the ancient life of this region is Dr. Max Schlosser of Munich. The combined observations of the four palæontologists, Owen, Koken, Schlosser, and Matsumoto, are to the effect that the life of China in Upper Miocene and throughout all Pliocene times was very similar to that of India; the tropical forests were full of primitive elephants known as stegodonts, low-bodied, with long, straight tusks and low-crowned teeth. It was only toward the close of the Pliocene that the higher types of elephants related respectively to the mammoths and to the African elephants, began to appear in China as in India, while the Indian elephant type, the *Elephas indicus* of Linnaeus, appeared in these lands only in comparatively recent times. Relatively recent also was the invasion of China by migrants from North America, including species directly ancestral to the true horses, followed by the deer and animals of the northern forests. Doctor Joleaud thinks that the Pleistocene fauna of Szechuan may be regarded as a real interglacial fauna, while that of Honan corresponds with a real glacial phase. After these phases there appeared in the "loess" of China the woolly rhinoceros, a horse of the modern type, and several species of true deer (*Cervus*), besides the Axis deer, so characteristic of the Oriental regions today. This comparison is interesting because it is in deposits of this age, broadly corresponding with the Chellean of Europe, that we may expect to find the early remains of man in China.

M. Edouard Harlé, engineer and distinguished palæontologist of the Pleistocene of France, has presented his precious collection of Pleistocene fossils to the Museum of Natural History of the City of Bordeaux. This collection of a lifetime, enhanced in value by the donor's numerous researches and publications upon it, comes largely from the southwest of France and includes remains of the northern type of seal, which found its way into the rivers of Dordogne in Pleistocene times; remains of the musk ox of southern France; remains of a monkey contemporary with man, found near Montsaunes; small rodents found in the shelters of Dordogne, which came from the steppes of Siberia during late glacial times; remains of the mammoths from the great deposits near Torralba found contemporary with the Chellean man in Spain and Portugal; the equally rare jaw of a reindeer, found at Santander not far from the grotto of Altamira.

The writer who describes this gift adds: "It is strange to think that, outside of Paris, the only

natural history museums of France which are well developed are those of Lyons and of Strasbourg. The chief natural history riches of the country have been concentrated in Paris." This gift to Bordeaux of the rich palæontological collection of Harlé may mark the beginning in France of a movement of decentralization in natural history similar to that which is taking place in this country.

THE Piltdown man, *Eoanthropus*, discovered in 1912 in Sussex, England, appears not yet to have been assigned a secure place in the ancestral series. In the April issue of *Man*, Sir Ray Lankester contributes to the discussion. He has himself found a flint implement on the surface near the gravel pit in which the original finds were made and which he would add to the original Piltdown flints discovered above and below the skeletal remains. His discussion sums up to the effect that "we are not in a position to assume either that *Eoanthropus* manufactured flint implements, or, on the other hand, that he did not do so. To me it seems improbable that *Eoanthropus* had anything to do with flint implements at all, although more likely that he suffered from them rather than that he benefited by their use." N. C. N.

AN EARLY Chellean workshop site alleged to occur in a formation of late Pliocene date (!) precipitated a lively discussion at the meeting of the Royal Anthropological Society on May 3. From *Nature* we learn that the evidence, consisting of a number of ochreous flint implements, cores, flakes, etc., was presented by Mr. Reid Moir, who obtained the same on the foreshore exposed during low water at Cromer, Norfolk. The material is said to be referable to the lowermost stratum of the famous Cromer Forest Bed series, generally regarded as either Upper Pliocene or Lower Pleistocene.

Comments on the geological authenticity of the find varied considerably. Sir William Boyd Dawkins and others declined to accept the evidence as satisfactory. Professor Arthur Keith assumed a neutral attitude. Sir Ray Lankester and Mr. Reginald Smith, however, insisted that Mr. Reid Moir had made out a *prima-facie* case. N. C. N.

MADAME MARIE CURIE, the woman of genius from France, recently made an Honorary Fellow of the American Museum, has had crowded into her all too brief visit to our shores honors and homage such as come only to those whose attainments win spontaneous and universal acclaim. She has received the highest honors from our foremost men of science; no less than ten degrees from our colleges and universities; the precious gram of radium (valued at $100,000) together with mesathorium (valued at $22,000), placed in a costly mahogany box; a gold loving cup, and other substantial gifts. At a reception tendered her in Carnegie Hall, New York, President Pendleton of Wellesley College, announced the award to her of the special Ellen Richards Research Prize of $2000. The National Institute of Social Science presented to her the gold medal of the society, and the Chicago Section of the American Chemical Society bestowed upon her the Wolcott Gibbs Medal. Wherever she went the scientific world turned out to do her reverence. At fête after fête she was the guest of honor and from the speaker's platform the leading men of science in the land paid tribute to her genius.

In New York among the attentions shown her were the reception at the American Museum, described in NATURAL HISTORY for March-April, p. 162; a luncheon given under the joint auspices of the American Chemical Society, the American Electrochemical Society, the Chemists Club, and the American Sections of the Société de Chimie industrielle and the Society of Chemical Industry; a reception at Carnegie Hall tendered by the American Association of University Women; and a dinner in her honor arranged by the National Institute of Social Science.

The principal incident of her sojourn at Washington was the memorable presentation to her of the gram of radium, solemnized with appropriate ceremonies, at the White House. She also enjoyed the distinction while in that city of setting in motion the machinery of the new low temperature laboratory of the Bureau of Mines, which is dedicated to her.

In the high honors shown Madame Curie, not only has womanhood been exalted; not only have two great nations which she represented, the land of her birth and the land of her adoption, been honored, but also things of intellectual and spiritual value have been rightly recognized as of more worth than things of merely material value. Those who looked at Madame Curie beheld a woman of small stature, slender build, and manifestly limited physical strength; a woman of middle age, with pale face, deep-seated gray eyes, intensely concentrated in expression; simple in bearing, unassuming, perfectly poised while receiving the greatest honors the scientific world has in its power to bestow. Yet none who came near her could fail to feel they were in the presence of a truly great personality, even if they had not known the record of her splendid achievements. This woman has had the keen intellect, the moral strength of endurance and persistence in the face of trials extending over a long period of years, and the spiritual greatness of soul when successful in her quest to turn and freely give the hard-won result of all her labors, to humanity. How greatly she prized the radium she gave away is witnessed by the fact that when she was asked a few

months ago what she would most like to have in the world, she instantly replied, "A gram of radium under my own control." The women of America have presented her with that gram.

Madame Curie returns to her laboratory in Paris with the good wishes of the nation whose guest she has been. She has already accomplished a work that will put her name among the immortals but her work is not yet done. It is the hope—it is more, it is the conviction,—of our nation, that equipped with the means of pursuing her experiments, she will win new triumphs, extending the bounds of the known and through the application of her discoveries alleviating still further the sufferings of mankind.

WE learn from *Nature* of a number of interesting happenings at the fifteenth meeting of the Australasian Association for the Advancement of Science, held at Melbourne in January:—

"Section D. (*Biology*).—It was decided that a resolution be sent to the Premier of South Australia emphasizing the great national and scientific importance of the preservation of native fauna and flora, and congratulating the Government on the legislation recently passed constituting Flinder's Chase, on Kangaroo Island, a national reserve for fauna and flora. Immediate steps should be taken to give full effect to that legislation. The Government is further urged to give full consideration to the unique importance which attaches to the constitution of the whole of Kangaroo Island as a national fauna and flora reserve, as well as to the protection of the land, fresh-water, and sub-aquatic fauna and flora of all the islands in South Australian waters, other than Kangaroo Island, which are actively used for farming pursuits."

The presidential address by Sir Baldwin Spencer dealt with the social organization and racial derivation of the Australian aborigines. It was pointed out that "the remarkable homogeneity of all Australian tribes, even with regard to the details of their social organization, gives no suggestion of outside influence. This homogeneity, existing side by side with the most remarkable differences in skull measurements, customs, beliefs, and arts revealing an extraordinary range of variability, presents a difficult problem quite insoluble on the theory of interactions of various immigrant peoples reaching Australia at different times. The statement of Professor Keith and others that the Australian race might have served as common ancestors for all modern races may be understood on the theory that it is the survivor of such a one that has been isolated for long ages in Australia, and has been practically uninfluenced by contact with other peoples."

AN ANNOUNCEMENT has recently been made by the Harpswell Laboratory for Biological Research that it has transferred its headquarters from South Harpswell, Maine, in Casco Bay, to Mt. Desert Island, where it has been allotted a tract of fifteen acres on Salisbury Cove by "The Wild Gardens of Acadia" corporation. This new site, to be known as the Weir Mitchell Station of the Harpswell Laboratory, has excellent shore frontage and unusually favorable life conditions. The cold waters of the region are extraordinarily rich in both common and rare marine forms, including those of exposed rocky shores, muddy coves, shallow and deep-sea bottom, estuaries, bays, and open seas. Depths of more than one hundred fathoms are found within twenty miles, where there is an abundance of deep-sea species usually accounted rare. The mountainous character of the island, which rises to forested peaks of fifteen hundred feet in the southern half, gives an excellent opportunity for terrestrial life studies, while lakes, streams, and marshes furnish a rich fresh-water fauna and flora. It is a region of unspoiled virgin beauty, and has the advantage of contact with the Wild Life Sanctuary of Lafayette National Park, which is also situated on the island.

The Harpswell Laboratory was founded at South Harpswell, Maine, in 1898 as a summer school of biology, by Professor J. S. Kingsley of Tufts College. It has an enviable record for research and biological instruction. In its new location it is under the directorship of Professor Ulric Dahlgren of Princeton, the well-known authority on bio-luminescence in animals, who will contribute an article on this subject to a subsequent number of NATURAL HISTORY.

ONE is not apt to associate serious accomplishments with a creature as playful as the squirrel; yet the Forest Service, United States Department of Agriculture, is authority for the statement that to it more than any other agency is due the extension of our valuable black walnut groves. The little creature, providing in time of plenty for the lean period of winter, scurries about the open areas at the forest edges, seeking hiding places in the soil for the nuts it gathers. Not all of these nuts are dug up again. In time those that are overlooked grow to be sizable trees.

The groves thus planted by previous generations of squirrels were drawn upon during the war for the manufacture of gunstocks and airplane propellers. No other wood has proved as suitable for gunstocks as black walnut.

IN COÖPERATION with the leaders of various organizations interested in camping and with the commissioners of the Palisades Interstate Park, Teachers College offers each spring a course of instruction for camp directors and camp councellors, conducted by Dr. Elbert K. Fret-

Mr. B. T. B. Hyde, director of scout museums at Kanohwahke Lakes, and one of his assistants, absorbed in the task of making vivaria. The study of live creatures, which, when caught, are housed in these vivaria, is a favorite occupation of the boy scouts at the camp

well. The permanent camp movement has grown greatly in recent years, being but one of several manifestations of a greater emphasis laid on outdoor recreations. Fifteen years ago such camps were conducted by a very few individuals without coördinated effort. Today haphazard undertakings of that character have been replaced by well organized camps for boys and girls, in which trained leadership is provided. It is through such courses as that conducted by Dr. Fretwell that camp directors are developed and the camp organization is perfected.

The plan of this course is most comprehensive. The talent and experience of those engaged in directing camps are offered for the benefit of the students. One of the features of the course is a week spent at Bear Mountain in the Palisades Interstate Park. Here the students find comfortable housing at the inn run under the auspices of the Interstate Park, and gain practical experience in the work for which they are preparing themselves.

The feasibility of establishing a museum for nature study in a camp was demonstrated by Mr. B. T. B. Hyde, the director of the scout museums at Kanohwahke Lakes and director, in connection with Dr. Fretwell's course, of the museum at Bear Mountain. At the latter place he was ably assisted this spring by Professors Sanderson and Frances, of the New York College of Forestry, Dr. Lawrence Palmer of Cornell, and Professor William G. Vinal, of the Rhode Island College of Education. The students were divided into four bands or groups that were led successively by the several instructors on the nature hikes. The material collected was brought to the museum, identified, and prepared for exhibition.

The making of aquaria based on Dr. Palmer's plans was successfully engaged in under Mr. Hyde's supervision and the finished containers were stocked with the aquatic life collected.

The building up of camp museums, a movement initiated by Mr. Hyde, is becoming a recognized activity of summer camps, many of which are now emphasizing this feature. Mr. Hyde is establishing twenty-five camp museums in the Interstate Park this summer.

"NATURAL HISTORY"

JULY–AUGUST ISSUE

DR. T. A. JAGGAR, JR., volcanologist, director of the Hawaiian Volcano Observatory, has for years lived in close association with the great active volcano Kilauea, studying it, recording its behavior, analyzing its gases and discharges, photographing it in its grand upheavals with ruptured surfaces and flowing lava streams. He will give an account of his "Experiences in a Volcano Observatory," by way of introduction to a splendid series of illustrations of recent volcanic happenings at Kilauea and Mauna Loa.

MR. ROLLO H. BECK, leader of the South Sea Expedition, will contribute an article entitled "Visiting the Nests of Sea Birds by Automobile," in which he gives a spirited account of his observations, under novel circumstances, of the bird life of Christmas Island.

THE recently erected Miami Aquarium is winning cordial recognition from those who are aware of the important work it is accomplishing in furthering knowledge of the life of warm seas. An account of this aquarium, written by MR. JOHN T. NICHOLS, associate curator of recent fishes at the American Museum, will be one of the striking features of the forthcoming number. The article will be effectively illustrated with pictures supplied in part by Mr. Nichols and in part by Mr. John Oliver La Gorce, secretary and treasurer of the Miami Aquarium Association.

FISHES of Miocene Age found in California are of particular interest in that they represent the immediate ancestors of fishes that are swimming about the seas today. Illustrations of some of these early fishes prepared by Mr. Atkinson, under the direction of DR. DAVID STARR JORDAN, will therefore have exceptional interest.

TOO frequently is the spider looked upon as a horrible creature, fit only to be crushed under foot. MR. WILLIAM M. SAVIN, in an article on "The Much Despised Spider—Harmless, Beneficial, Interesting," shows how fascinating a field of study awaits those who will take the trouble to investigate the ways and habits of these creatures. The article is accompanied by unusually fine pictures in color, as well as in black and white, showing different webs and their spinners. That spider silk can be made of service to man—although admittedly the industry has only restricted opportunities—is made clear in an article by DR. ALEXANDER PETRUNKEVITCH, one of our foremost students of spiders. The spider, however despised by the white man, holds a place of no little importance in Indian mythology, and this aspect of the subject is considered in an article supplementing the two just mentioned.

AMONG the natural products for which the white man is heavily indebted to the American aborigines, is Indian corn or maize. Two supplementary articles describe the methods of raising and preparing this cereal among the Indians. MR. CHARLES W. MEAD, assistant curator of Peruvian archæology, at the American Museum, gives a general account of corn culture in South as well as North America; MR. HENRY M. STEECE confines his article to a consideration of the agricultural methods applied to this cereal by the Indians of our Southwest.

THAT trees have an individuality is recognized by every one. The form or outline, the development of the branch system, the conditions of growth, adverse or favoring, are among the factors that give the individual tree a character that differentiates it from its fellows. It is on the structure of trees and their æsthetic appeal that DR. JOHN W. HARSHBERGER, professor of botany at the University of Pennsylvania, dwells in his article entitled, "The Artistic Anatomy of Trees." This article is accompanied by a series of beautiful photographs and is a noteworthy contribution to the July-August issue.

HAVING indicated tentatively the articles that are to find place in the July-August issue, it may be in order to cast a glance ahead to the issue for September-October. Without entering into a specification of the articles that are to appear in it, it may be stated that the issue will give emphasis to certain of the west coast countries of South America, with particular stress on the recent acquisition by the American Museum of a remarkable collection of Peruvian gold.